

NEW YORK FRUIT QUARTERLY

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Editorial

Maintaining the New York Apple Research Order



*"From season to season,
trees bridge one generation
to the next."*

Having recently read these words by a gifted, but anonymous writer, I recognize how appropriate they are to the legacy entrusted to our apple growers. We are the stewards of the next generation and our skilled nurturing continues the cycle.

These are severely trying times for the apple industry. The pressures placed upon our state and nation by the tragic events of September 11th, the actions of NAFTA, the importing of apples from China and other foreign countries, coupled with instant communication and rapid world-wide transportation have created a major impact on the industry. Much of this impact has been negative for New York growers, but we must focus attention on our positives. The New York apple industry has a large inventory of productive orchards, storage, packing, shipping, and marketing capabilities to deliver an excellent product to the consumer.

As we move from season to season, one thing we can be certain of is change. How we handle that change will be our greatest challenge. Twelve years ago, New York growers banded together to create the New York Apple Research Order to help deal with change. This resulted in an outstanding collaboration between Cornell University, the Geneva and Hudson Valley research stations, and Cornell Cooperative Extension, which has concentrated on the needs of the industry. Through the years the outstanding work of researchers in pomology, plant pathology, plant breeding, rootstocks, post harvest physiology, apple processing, genetic research, new product development, and disease resistance has provided us with a reservoir of knowledge and skill unmatched anywhere. From 1996 to 2001 alone, 47 different projects were funded, with a total grower investment in excess of \$750,000.

We must now assess our strengths, recognize our weaknesses and respond in a unified manner to address the future as an apple industry. To that end, we on the Apple Research and Development Board urge you to support the re-vote on the apple marketing order this year. If we continue to work together to reach common goals, perhaps this generation will bridge to the next as the trees bridge from season to season.

Please vote to maintain the ARDP this year.

Anthony Moriello
Apple Grower
Chairman, ARPD

CONTENTS

The New York State Apple Research and Development Program: Ten Years of Successful Research Support for the Apple Industry
Terence Robinson.....3

Apple Cultivars: A Geneva Perspective
Susan Brown and Kevin Maloney.....21

2001 IDFTA European Tour: Integrated Fruit Production in Europe
Deborah I. Breth.....29

FRONT & BACK COVERS: New and promising apple varieties. See article by Susan Brown on variety testing in New York.

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Editors:

Terence Robinson and Steve Hoying
Dept. of Horticultural Sciences
New York State Agricultural Experiment Station
Geneva, New York 14456-0462
Telephone: 315-787-2227
Fax: 315-787-2216

Subscriptions: \$20/year. Contact Karen Wilson,
NYSHS, PO Box 462, Geneva, NY 14456
or call: 315-787-2404

Advertising: Warren Smith: 845-255-1442
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NYSAES, Geneva

The New York State Apple Research and Development Program: Ten Years of Successful Research Support for the Apple Industry

Terence Robinson

Associate Professor of Horticulture
NYSAES, Cornell University, Geneva, NY

Over the last decade, the New York State Apple Research and Development Program (ARDP) has played an essential role in supporting the New York apple industry. Along with the New York Apple Association (NYAA) which promotes New York apples, the Apple Research and Development Program has worked to support apple growers by funding research aimed at improving the production, harvesting, storage and market quality of New York apples.

New York apple growers have been funding research on apples for more than 25 years. In the 1980s, a voluntary program existed in Western New York called the Apple Research Association (ARA). Jim Oakes of Lyndonville, NY, was the primary leader of that effort. In that program, processors matched grower contributions. Combined annual contributions between growers and processors were about \$25,000-\$30,000 and was used to fund numerous research projects at Cornell. However, that amount of money was not enough as federal and state money for research was limited in the 1980s. Also, the ARA included only a portion of Western New York growers and did not include Eastern New York growers at all.

In 1990, the New York State Horticultural Society, led by Walt Blackler, as president, and Peter TenEyck, as vice-president, appointed a committee to study whether or not a better method of funding research could be implemented. The committee, led by Peter Conklin of Hudson, NY,

along with George Lamont of Albion, NY, Tré Green of Chazy, NY, Don Neilsen of the NYS Dept. of Ag. and Markets, and Warren Stiles and Terence Robinson of Cornell University, recommended the formation of a research and development program under the Agricultural Marketing Order Law Section 294 of Article 25. The Hort. Society Board unanimously adopted the idea and began gathering signatures of growers on a petition to the Dept. of Ag. and Markets to hold a vote for all growers to determine if a program of mandatory contributions for research should be started in New York State. The vote was strongly in favor of the research program. Thus, beginning in 1990, growers began to contribute 2 cents per hundred weight of apples toward a fund that sponsors all types of research projects that benefit the growers. The program was named the New York State Apple Research and Development Program (ARDP). A nine-member grower advisory board was nominated by growers and appointed by the commissioner of agriculture to oversee the expenditure of the funds.

Since 1991, the ARDP has collected about \$150,000-200,000 annually. The ARDP Board has annually considered proposals from researchers at Cornell and other institutions and funded those they feel will be of the greatest value to the New York apple industry. In addition, the apple processors have continued to voluntarily contribute to the ARA. Money from the ARA is used to fund some re-

The Apple Research and Development program which began in 1991 is a grower-funded research market order that funds research projects to improve the production, storage and marketing of New York apples. Over the 10 years of its history, it has made a significant impact on the research conducted at Cornell and resulted in significant improvements for apple growers.

search projects independently and to jointly fund others with the ARDP.

Over the last 10 years, the ARDP has funded a variety of projects that have helped growers improve the production, harvesting, storage and marketing of New York apples. The results of these research projects have been published in the *NY Fruit Quarterly* which is sent to all apple growers and is the official publication used by the ARDP to communicate the results of the research they fund to the growers. In addition, results have been presented at numerous extension meetings over the last 10 years.

Growers should be proud of the efforts they have made to work together to fund research that benefits the entire industry. The money the growers have raised has been critical to keeping researchers at Cornell working on apple production, storage and marketing problems. The ARDP Board has worked hard to spend the money wisely in ways that will help the industry.

The ARDP was set up so growers would continue to have control of the program. The program depends on the support of the growers and must be voted on every six years. This summer, growers will again vote on whether or not to continue the ARDP program. To assist growers to understand how their money is spent, this issue of the *NY Fruit Quarterly* is dedicated to the ARDP, with short sum-

maries of each of the projects funded over the last two years. They range from apple production projects to studying the health benefits of eating apples.

DEVELOPMENT of NEW APPLE VARIETIES and PRODUCTS

Assessing the Commercial Potential of Advanced Apple Selections and New Varieties of Interest

Susan.K. Brown and
Kevin.E. Maloney

Dept. of Horticultural Sciences,
Cornell University, Geneva, NY

Through this project, we are evaluating the orchard performance, disease susceptibility and storage and shelf life of new apple selections and cultivars. We provide growers with information on varieties they might be interested in for testing. Investing in new cultivars can be risky if faults become apparent after the orchard has been established. Our tests at Geneva indicate potential problems, such as the susceptibility of the popular variety 'Honeycrisp' to soft scald, the russet susceptibility of 'Delblush', and the fire blight susceptibility of 'Zestar'. With this information, growers can assess if their site, management practices, and cold storage regimes place them at high risk for these disorders. Multiple year testing of varieties enables us to provide information on regularity of cropping, tendency for pre-harvest drop, fruit skin russetting, moldy core and other storage disorders. Growers and processors have benefited from having additional information to base their decisions on which varieties to trial. Knowing the varieties' strengths and weaknesses allows the growers to better manage them. New varieties can be very profitable. By providing information on advanced selections from the Cornell program, other programs and nurseries,



Dr. Susan Brown pollinating apple blossoms to create new apple varieties.

growers can make better-informed decisions on new plantings.

Improvement of New York Apple Varieties and Rootstocks by Biotechnology Techniques

Herb Aldwinckle

Dept. of Plant Pathology,
Cornell University, Geneva, NY

The susceptibility of the most popular apple varieties and rootstocks in New York to diseases, especially fire blight, is a continuing problem for the state's growers. Although progress is being made with developing resistant rootstocks by conventional breeding, all new rootstocks must be thoroughly tested, which often reveals unexpected shortcomings. Breeding new scion (fruiting) varieties is much more difficult because of the need to combine resistances with world-class fruit quality. Biotechnology (genetic engineering, or GE) has great potential for producing disease-resistant apples, because it should allow introduction of one or a few genes for resistance without altering the desirable fruit characteristics of the best varieties for New York. We have now refined techniques for doing GE with apple, and have introduced several genes designed to increase resistance to fire blight into Gala apple. Some of these genes have now been shown to cause increased resistance during several years of field testing. Fruit from trees containing the genes has normal size, color, yield, and storage quality. The first genes that were available to us when we started the work, and which we used to show that GE does, in fact, work for apple, are not suitable for commercial use. Therefore, we are now using the efficient methods that we developed to produce resistant apple varieties with new genes that will be acceptable to industry and the public. Fire blight resistant apple varieties and rootstocks will be of great benefit to the New York apple industry by reducing crop and tree loss, and by eliminating the need for sprays to control the disease. They will benefit growers' bottom line, as well as being good for the environment.

Development of Extended Shelf-Life Apple Cider w/out Preservatives

Randy W. Worobo and
Olga Padilla-Zakour

Department of Food Science and
Technology, Cornell University,
Geneva, NY

The shelf life of fresh and pasteurized apple cider is very short (2 to 4 weeks,



Apple cider shelf life can be increased by special processing without chemical preservatives.

respectively). In an attempt to produce an extended shelf-life apple cider without preservatives, combinations of thermal processing such as pasteurization and hot-fill, ultraviolet light and dimethyl dicarbonate treatments are being investigated. These combinations are also being evaluated for the potential to produce a short shelf-life apple cider without chemical preservatives that will not require refrigeration.

Processing Apple Slices for Long Shelf Life

J.G.N. Amisoh¹, J.H. Hotchkiss¹,
and C.B. Watkins²

¹Department of Food Science, Cornell
University, Ithaca, NY

²Department of Horticulture, Cornell
University, Ithaca, NY

Improved consumer convenience of apples may help increase consumption of apples. Fresh sliced apples have been shown to be a convenient and valued enhancement for fresh apples. The problem is the rapid deterioration of cut product. Fresh-cut produce is a \$10 billion business of which the apple industry has not captured a significant portion, so we are developing a process to increase the shelf life of cut apples. In our research, we expose apple slices to elevated atmospheric pressures containing 15 - 45% CO₂ for short periods of time (0-20 minutes) to quickly saturate the tissues. Our work suggests that high CO₂ (>15%), 1% O₂ (balance N₂) inhibits softening and the accumulation of off-aromas in fresh-cut apple slices. Saturating the apple tissue with similar atmospheres would further inhibit deterioration by rapidly penetrating the tissue and, when combined with anti-browning treatment, extend the shelf life

of cut apples. That work will provide a new procedure for processing cut apples. This would allow the industry to enter the cut product market and provide consumers with apples in a convenient form. It would also allow the development of new products including apple-based fruit salads and cut-apple products for use by consumers as ingredients in salads.

Down Regulation of Ethylene Production in Apples

Geza Hrazdina¹ and Herb Aldwinckle²

¹Department of Food Science and Technology, Cornell University, Geneva, NY

²Department of Plant Pathology, Cornell University, Geneva, NY

Most apples are produced for the fresh market and have to be stored under controlled atmosphere conditions to avoid softening. The softening of fruits is the result of structural changes in the cell walls. These structural changes are caused by the hydrolytic activity of such enzymes as polygalacturonase, cellulase and the diverse hemicellulases that are under the control of the ripening hormone ethylene. Ethylene is synthesized in plants from S-adenosyl-L-methionine by a short pathway that consists of two enzymes: 1-aminocyclopropane-1-carboxylic acid synthase (ACS) and 1-amino-cyclopropane-1-carboxylic acid oxidase (ACO). To interfere with ethylene synthesis in plants, we have cloned two ACS genes from ripening 'McIntosh' apples. The gene showing the closest similarity to the ripening-related ACS gene in other fruits was used to make antisense constructs. 'Royal Gala' plants were transformed with these antisense constructs using an Agrobacterium-mediated transformation system. Transgenic plants were propagated in tissue culture, micrografted to M.9 rootstocks in pots, grown in the greenhouse, and then planted in the field. Transgenic 'Royal Gala' fruits that were produced on these trees by manual pollination (under bee-exclusion netting during flowering) were evaluated for morphological characteristics, ethylene production, ACS activity and ripening parameters in the presence and absence of 1-methylcyclopropene (1-MCP) and ethylene. Our data indicate down regulation of ethylene production and softening was achieved in some transgenic lines. 1-MCP (1 ppm, 24h, 0oC) completely prevented the development of any ethylene formation in transgenic 'Royal Gala' apples. Ethylene treatment (50 ppm, 3h, 21oC) did not affect the eventual onset and magni-

tude of ethylene formation in transgenic fruits.

CROP PRODUCTION

Orchard Management Systems for Improved Yield and Quality

Terence Robinson¹, Steve Hoyal², Mike Fargione², Kevin Iungerman² and Alison DeMarree²

¹Dept. of Horticultural Sciences, Cornell University, Geneva, NY

²Cornell Cooperative Extension

The need to improve orchard production efficiency is causing many apple growers to plant high-density orchards. We have planted a series of orchard trials comparing several training systems and a range of tree densities from 150 to 2,200 trees/acre. Data from several of our experiments show that cumulative yields over the development years were largely a function of tree density with systems on dwarfing rootstocks (M.9 and M.26) giving the highest yields. The traditional system of Central leader/M.7 rootstock achieved less than one-third of the high density system. When data from several experiments were placed on the same graph, the relationship of tree density and cumulative yield was curvilinear. Over the range of tree densities from 200 trees/acre to 1,000 trees/acre, the slope of the relationship was about 6.2 packed boxes/tree indicating that as tree density was increased an additional cumulative yield of 6.2 boxes per acre was obtained for each additional tree planted per acre. This would be about six times the cost of the tree. At the higher tree densities, the gain in cumulative yield was very small. This fits the classical law of diminishing returns which states that additional increases in an input factor (tree density) produces a smaller and smaller increase in an output factor (yield). At the high end of this curvilinear relationship, additional increases in trees density would not produce enough extra yield to pay for the additional costs incurred to purchase and plant the extra trees.

Our latest economic analyses show that under New York conditions and fruit pricing, a tree density of about 400-800 trees/acre is more profitable than lower or higher densities. The results of our economic analysis may not be valid for other parts of the world with different fruit, tree and land prices. Nevertheless, from these studies we conclude that planting more trees per acre will result in greater early yields and profitability up to about 1,000

trees/acre. Above this density, it appears, that despite producing greater cumulative yields, profitability is only slightly greater and in some cases less than lower densities. The economic risk is increased significantly with very high density orchards. The relationship of tree density and early cumulative yield can be modified by a number of factors including initial tree quality and pruning severity which would change the optimum economic density.

Robinson, T. and S. Hoyal. 2001. Processing apple planting systems trials. *New York Fruit Quarterly* 9(4): 17-19.

Factors Affecting the Performance of Newly Planted Apple Trees

Terence Robinson, and Alejandro Valencia

Dept. of Horticultural Sciences, Cornell University, Geneva, NY

One of the pressing needs of the New York apple industry is to replant orchards to new varieties. The large capital investment required to plant a new orchard makes good tree growth and early yields essential to their success. The dwarfing apple rootstocks are more sensitive to environmental stresses and poor management. This project has focused on tree quality, preplant and postplant fertilization, and irrigation. Our experiments have shown that trickle irrigated trees produce more growth than non-irrigated trees which resulted in significant increases in cumulative yield over the first eight years. Trickle irrigation alone increased yield over the first eight years by about 16% but, when trickle irrigation was combined with ground fertilization or fertigation, yield was increased about 25%. Fertigation of young trees has also improved tree growth and early yield, but has been no better than trickle irrigation with ground fertilization. In addition to improving total yield, irrigation and fertigation increased fruit size. The magnitude of the improvement in yields over the first six or seven years from trickle irrigation appears to justify the investment in trickle irrigation for humid climates such as New York's, especially in dwarf apple orchards where significant yields are expected in the second to fifth years.

However, the economic benefit of fertigation versus ground-applied fertilizer with trickle irrigation is less clear and may not be justified based on the cumulative yields from our experiments to date. In the last two years, we have studied the effect of late season nursery urea sprays on the growth of different sizes of maiden

apple trees on M.9 rootstock in the first year in the orchard. Total nitrogen amount per tree (g/tree) at time of planting was increased by foliar urea sprays applied to the trees the previous fall in the nursery and was reduced by either root pruning, or canopy pruning. The amount of nitrogen per tree was positively correlated and root:shoot ratio was negatively correlated with total shoot growth, tree dry-weight increment and leaf area. The greatest leaf area development during the first year in the orchard was obtained with the unpruned (root or canopy) trees while trees that received both root and canopy pruning had the least leaf area development. Root pruning had a minimal effect on growth during the first year in the orchard while canopy pruning had a larger effect.

Valencia, A. and T. Robinson. 2001. Effect of nitrogen content, root:shoot ratio, trunk caliper, and number of feathers on canopy development of young apple trees after transplanting from the nursery. *HortScience* 36:462 (Abstr.)

Evaluation of New Apple Rootstocks

Terence Robinson¹, Steve Hoying², Mike Fargione², and Kevin Iungerman²

¹Dept. of Horticultural Sciences, Cornell University, Geneva, NY

²Cornell Cooperative Extension

The new series of Cornell-Geneva rootstocks have the potential to replace existing rootstocks because they have resistance to fire blight and phytophthora root rot. Four stocks have now been released (G.16, G.30, G.65 and G.11) and are being commercialized. About a dozen more elite selections are in the pipeline. We have established a series of trials within New York State to further evaluate their commercial potential. We are also gathering promising rootstocks from around the world for trial in New York. Data from these trials will give growers



High density orchards are capable of high early and sustained yield.

unbiased information about the potential of CG, Supporter, Morioka, Budagovsky, Pillnitz and JTE stocks. From trials planted in 1992-1998 we have identified G.16, G.11, CG.3041, and CG.4202 as the best elite dwarfing fire blight resistant rootstocks. In two grower trials, almost all trees on M.9 or M.26 were killed by fire blight in 2000, but almost none of the trees on G.16, G.11, CG.3041 or CG.4202 were killed. Other less tested dwarfing CG clones that have exceeded the performance of M.9 or M.26 are CG.3902, CG.3007, CG.4003, CG.4247, CG.5757, CG.6737, CG.3029, CG.50, CG.26, CG.995, CG.12.3, and CG.38. Among semi-dwarfing stocks, G.30 has been the most productive and far exceeds M.7. Other less tested semi-dwarfing clones that have exceeded the performance of M.7 are CG.5935, CG.5012, CG.5046, CG.5202, CG.5179, CG.6210, CG.6874, CG.756, and CG.7760. Among vigorous stocks, CG.6239, CG.6253, CG.6723, CG.7707, CG.8189 exceeded the performance of MM.111. G.16 trees have generally grown slightly larger than M.9 trees, but are smaller than M.26. Trees on G.16 have been as precocious and productive as M.9 and have shown excellent fire blight resistance. We believe G.16 with its high fire blight resistance may be the best practical alternative to M.9 for successful high density plantings in the East.

The new CG rootstocks—G.16 and G.30—are being sold commercially by most US nurseries. G.11 stoolbeds were planted by commercial nurserymen in 2001 and so should be available in 2003. We have decided to release CG.4202 in New Zealand during May 2002 and in the US in 2004. Nurseries are beginning to bulk up these stocks for commercial sale. We also intend to release CG.3041 and CG.5935 in 2004.

Improving the Cold Hardiness of Young Bearing Apple Trees

James R. Schupp

Dept. of Horticultural Sciences,
Cornell University, Highland, NY

Cold damage problems in the Northeastern US most often occur in late fall and early winter when hardening of the trees is delayed. The objective of this study was to determine if fall foliar sprays of copper chelate and Apogee induced earlier cold tolerance. In 1999, we tested four concentrations of Cu-EDTA applied by handgun, and evaluated air-blast sprays of 150 and 75 gallons per acre on young McIntosh/M.26 apple trees growing in a commercial orchard in the

Champlain Valley. In September 2000, experiments were conducted on a block of late growing three-year-old McIntosh/M.9/MM.111 trees in a commercial orchard in Burnt Hills, NY. The treatments were: a) Untreated control; b) Apogee; c) Cu-EDTA; and d) Apogee, followed by Cu-EDTA. Shoots were collected in early December, and again in late January, and then were subjected to a range of cold temperatures in a programmable cold chamber at the Hudson Valley Lab. Cold injury resulting from these temperatures was evaluated by determining electrolyte leakage using a conductivity meter. Results of this research showed that while both handgun and air-blast sprays of Cu-EDTA were highly effective defoliant at concentrations of 0.1% copper and up, they did not enhance early winter cold hardiness. Stem tissue on Apogee-treated trees showed less damage from low temperatures in early December. Apogee reduced electrolyte leakage by 17% and 25% at -11°F and -22°F, respectively. These results provide initial evidence that treating actively growing trees in the autumn with Apogee increases early winter cold hardiness. Further study is needed to confirm these results before this method can be put into practice.

Schupp, J. R., L. Cheng, W. C. Stiles, E. Stover, and K. Iungerman. 2001. Mineral nutrition as a factor in cold tolerance of apple trees. *NY Fruit Quarterly* 9(3): 17-20.

Development of Chemical Thinner Alternatives

¹Jim R. Schupp and ²Terence L. Robinson

Dept. of Horticultural Sciences,
Cornell University, ¹Highland, NY,
and ²Geneva, NY

With small-fruited varieties like 'Empire' and 'Gala', the importance of early thinning to attain good fruit size is increasingly recognized. Interest in blossom thinning has increased with the uncertainty surrounding the future market and regulatory status of carbaryl, a carbamate insecticide widely used in chemical thinning strategies. The registration of carbaryl may be threatened by future Food Quality Protection Act actions, and the use of carbamates may limit market access to selective fruit processors or supermarkets in the United Kingdom. Growers will need alternatives to carbaryl should it no longer be an option. This is a new project funded for 2002.

Four studies are planned for 2002 with the following objectives: a) to test lime sulfur as an alternative to carbaryl in conventional thinning programs; b) to determine the application time that pro-

duces the best thinning response to fish oil + lime sulfur sprays; c) to test alternatives to fish oil for combination with lime sulfur in thinning sprays; and d) to determine the effect of changing the rates and ratios of fish oil and lime sulfur on thinning efficacy. Our preliminary results have shown that a tank mix of fish oil with lime sulfur (FOLS) is a very effective thinner when applied at 80% bloom. FOLS sprays increased fruit size and return bloom of Delicious apple in 2000. FOLS is organically acceptable, providing organic growers with an alternative to expensive hand thinning for the first time ever. An initial evaluation of post-bloom FOLS in 2001 showed that this timing was more effective for thinning 'Gala' and 'Golden Delicious' apples than treatments applied during bloom. This finding, if confirmed in future trials, will be very important for increasing the ease and usefulness of this strategy for apple growers. The later timing will permit the grower to complete an appraisal of initial fruit set before the treatments need to be applied, largely bypassing the threat of frost. It will also greatly relieve the pressure to apply these materials within a rigid time frame, enabling growers to wait for optimal spray conditions and to cover a greater amount of acreage than possible with a true blossom thinner. This line of research will soon provide New York apple growers with one or more new chemical thinning options for those who wish to address the concerns about carbaryl in export or processing markets, or those who seek organically acceptable thinners that are cost effective.

Factors Affecting the Efficacy of Chemical Fruit Thinning

Terence Robinson

Dept. of Horticultural Sciences, Cornell University, Geneva, NY

The decisions concerning chemical thinning (chemical, rate and timing) are the most critical ones a grower makes each season, and the least predictable. Understanding how environmental conditions affect thinner response will improve our ability to predict response and thus improve the results of chemical thinning and the value of the crop. Field studies were conducted in 2000 and 2001 with 6- and 7-year-old Gala and McIntosh trees on M.9 rootstock, and Delicious apple trees on M.26 rootstock where single application sprays of a tank mix of 75 ppm of 6-benzyladenine (BA) plus 1 pt. of Carbaryl (Sevin XLR Plus) per 100 gal water, or 7.5 ppm of Naphthaleneacetic Acid

(NAA) (Fruitone N) plus 1 pt. of Carbaryl per 100 gal of water were applied at 3- or 4-day intervals beginning at petal fall until 28 days after petal fall. Trees were sprayed with an airblast sprayer at 100 gal per acre using a 2X concentration of chemicals. In both years, a prolonged cool post-petal fall period resulted in slow fruit growth rate and poor thinning during the traditional thinning window. Thinning effectiveness was poor when fruits were smaller than 15mm and improved when fruits were relatively large between 15 and 20 mm. In 2000, this later period coincided with a warm period, but, in 2001, this coincided with one of the coolest periods during the experiment. It appears that in cool years, the applications of fruit thinning chemicals should be delayed until fruits are relatively large. These results are in contrast to our longstanding theories about fruit thinning and temperature and our general recommendation that NAA or BA be applied between 7 and 12 mm king fruit size. A possible explanation is that in cool years when fruit growth after petal fall is slow, carbohydrate reserves used to supply fruit growth are not reduced to a low level, where the mild stress from chemical thinners applied under cool conditions would cause some fruits to abscise. In such years, a relatively large fruit size is required before reserves are at a low point where they are most susceptible to chemical thinners. These results indicate that, in cool years, it is better to wait for relatively large fruit sizes before fruit thinners are applied.

Comparing Foliar Nitrogen with Soil Applied Nitrogen on Apple Yield, Fruit Quality, and Tree Cold Hardiness

L. Cheng¹, and J. R. Schupp²

¹Department of Horticulture, Cornell University, Ithaca, NY

²Department of Horticultural Sciences, Cornell University, Highland, NY

The objective of this project is to compare fall foliar urea application with traditional spring soil N fertilization to determine the best nitrogen management regime for optimizing apple yield and quality in commercial apple orchards under New York soil and climate conditions. Mature Marshall McIntosh/M.9 and Empire/M.7 trees received one of the following four N treatments at the same rate of 46 lbs/acre: (1) soil applied N in the spring (control); (2) foliar urea sprayed twice at weekly intervals after harvest; (3) 50/50 split between fall foliar and

spring soil application; and (4) 36/64 split between spring foliar and soil application. Fall foliar urea application to Marshall McIntosh increased reserve nitrogen levels in spurs and shoots. However, nitrogen content of leaf samples taken in late July the following year, was slightly lower in fall foliar N treatment than in the control and the split application treatments. There was no significant difference in fruit number, fruit size, soluble solids, firmness, and yield among the four treatments, although spring foliar and soil split application tended to give the highest fruit number and yield. No difference in leaf N content, yield, and fruit size was observed in Empire trees among the four N treatments. There was no difference in cold hardiness in either Marshall McIntosh or Empire trees among the four treatments. Whole tree excavation after fall foliar 15N-urea application indicated that nitrogen derived from fall foliar urea contributed 15% of the total tree nitrogen and increased tree N concentration by 16.3%. These results indicated that fall foliar urea application did improve tree reserve N status in the fall, but it appears that, when applied at the same rate, fall foliar urea application does not have any advantage over soil application in supporting tree growth and yield.

Seasonal Patterns of Root Growth and Lifespan in M9, M26 and B9 Rootstocks in New York

Alan N. Lakso and Terence L. Robinson

Dept. of Horticultural Sciences, Cornell University, Geneva, NY

Although the roots of apples are a critical component of trees, we know very little about them, especially in our climate. For two years, we have studied the patterns of when new roots are produced and how long they live in the field with three dwarfing rootstocks (M9, M26, B9) under Gala trees. The results so far have shown that the three rootstocks displayed the same general patterns as to when they grow and how long the new roots live over the two years examined. However, the seasonal patterns of root production varied tremendously from year to year. In 2000, most new roots were produced in June and July. In contrast, in 2001, a flush of new roots occurred between budbreak and bloom, few new roots were produced between bloom and harvest, but a large flush of root production occurred immediately after harvest in late September/early October. Previous studies in New York with M.9 and other stocks

suggest that the June-July flush of roots is more normal, but clearly root growth can vary dramatically from year to year. We feel that the warm spring period in 2001 combined with very heavy crop loads and drought, limited root growth to the early flush until harvest, and a heavy rain relieved the limitations. Then a fall flush could occur. In general, new apple roots remain white (the most physiologically active stage) for about 3-4 weeks, then turn pink or brown for some weeks to months before dying. Full root lifespan analyses are not yet completed as they require several years to be sorted out.

CROP PROTECTION and INTEGRATED FRUIT PRODUCTION

Development of an Integrated Fruit Production (IFP) Protocol for New York Apples

Terence Robinson¹, Art Agnello², Julie Carroll³, LaiLiang Cheng⁴, Ian Merwin⁴, Harvey Reissig², David Rosenberger⁵, James Schupp¹, Richard Straub², William Turechek⁵, Deborah Breth⁶, Mike Fargione⁶, Stephen Hoying⁶ and Kevin Iungerman⁶

¹Department of Horticultural Sciences, Cornell University, Highland, NY

²Department of Entomology, Cornell University, Geneva, NY, and Highland, NY

³NYS IPM Program, Cornell University, Geneva, NY

⁴Department of Horticulture, Cornell University, Ithaca, NY

⁵Department of Plant Pathology, Cornell University, Geneva, NY

⁶Cornell Cooperative Extension

The recently adopted strategic plan (2001) for the New York apple industry calls for Cornell to develop a market oriented integrated fruit production (IFP) program for apples in New York. Industry leaders have indicated that an IFP program is necessary to keep the industry competitive both from a production perspective and also from a marketing perspective to maintain and expand market access. New York marketers report that apple buyers from Europe are beginning to require greater and greater environmental and food safety characteristics for the fruit they purchase. At the moment, these are largely aimed at the packing plant, but, recently, they have indicated they will likely proscribe specific production and pest management practices beginning in 2002. The New York apple in-

dustry can act in a proactive manner to keep these markets and make inroads in other European markets by developing an IFP protocol. We are developing a New York Integrated Fruit Production protocol which would detail eco-friendly pest management, disease control, weed control, fertilization and fruit thinning, packing and storage practices to assure apple buyers that New York apples are safe and are produced in an environmentally sound manner. Such programs are common in European countries where IFP has been in place for 10 years. The New Zealand apple industry instituted such a program three years ago. We are working collaboratively with the New York apple industry to develop and test a New York IFP protocol on growers farms. If this project is successful, a workable and respected IFP program for New York growers and marketers will result. This will help the New York apple industry assure foreign and domestic buyers that New York apples are safe and are grown in an environmentally sound manner. This would help the New York apple industry keep current markets and make inroads in other European markets.

Management of Obliquebanded Leafroller Damage and Insecticide Resistance with a Biorational Insecticide Program

H. Reissig, R. Straub, and A. Agnello

Department of Entomology, Cornell University, Geneva, NY, and Highland, NY

This study was conducted on growers' farms (Cooperators: Richard Endres, Todd Furber, Ed and Seth Burnap, Lynoaken Farms, Glendale Farms) and showed that resistance to organophosphates remained relatively stable in the field populations of OBLR during the three years of the study, despite the absence of sprays of these materials. The control of OBLR in the soft pesticide programs was generally better than that obtained by growers in their standard pes-



Adult obliquebanded leafroller.

ticide treatments. However, adequate control of plum curculio was not obtained in most of the blocks, and, at the end of the study, damage was observed even in blocks that were completely free of this pest during the first season. These results showed that adequate control of the curculio cannot be maintained for multiple seasons without using special control sprays even in blocks that would not be considered to be at risk from this pest. This soft insecticide program did not provide adequate control of internal lepidoptera in some of the blocks for multiple seasons, although control of apple maggots was acceptable. Foliar pests such as tentiform leafminers, green apple aphids, white apple leafhoppers, and mites were not serious problems in the soft pesticide blocks. Tarnished plant bug damage was generally similar in growers' standard programs and the soft pesticide blocks. Secondary pests, such as rosy apple aphids and the San Jose Scale were problems in some of the soft pesticide blocks. However, the overall insect damage in the standard and soft pesticide was fairly similar during all seasons of the three-year study, except in one orchard, which suffered severe damage from curculio and internal lepidoptera. The costs of insecticides applied in the standard and soft pesticide programs were fairly similar.

Leafminer Damage and the Leaf/Fruit Ratio of Size-Controlled Apple Cultivars

R.W. Straub¹ and E. Stover²

¹Department of Entomology, Cornell University, Highland, NY

²Department of Horticultural Sciences, Cornell University, Highland, NY

Through experiments with both natural infestations and simulations of leafminer damage, it was determined that infestation greater than 2 mines/leaf caused significant reductions in fruit size of 'Empire' apple, but premature fruit drop was not affected.

Determination of the Damage Potential of the Leafhopper Complex on Apple

R.W. Straub

Department of Entomology, Cornell University, Highland, NY

This project provided support for assessing biological and occurrence characteristics of leafhoppers. Major impact was the determination that damage to apple was also being done by the previ-

ously unreported rose leafhopper, and current management protocols consider this an important finding.

Status of Borers Infesting Apple Burrknots and Their Management in New York Orchards

Dave Kain¹ and R. W. Straub²

Department of Entomology,
Cornell University, ¹Geneva, NY,
and ²Highland, NY

Prompted by the regulatory loss of Lorsban for postbloom use on apple, we performed field trials during two seasons and determined that petal applications of this material provided control of dogwood borer almost equal to the previously recommended timing.

Biological Mite Control in Hudson and Champlain Valley Apple Orchards Through The Distribution and Conservation of *Typhlodromus Pyri*

J. Nyrop¹, K. Iungerman², P. Jentsch¹,
and D. Straub¹

¹Department of Entomology, Cornell University, Geneva, NY, and Highland, NY
²Cornell Cooperative Extension

In contrast to Western New York where the mite predator *Typhlodromus pyri* is widespread and conserved to provide biological mite control, biological mite control has not been actively pursued in eastern New York orchards, at least in part because of the real or assumed absence of *T. pyri*. Previous research has shown that *T. pyri* can provide complete biological mite control in Eastern New York orchards. During 2001, we began a project to demonstrate this on a large scale. We found that:

- Of 11 Hudson valley (HV) and 8 Champlain valley (CV) orchards where *T. pyri* were released, the predator was also present in approximately 80% of the plots in these orchards where it was not released.
- Release of *T. pyri* increased densities of the predator two- to three-fold compared to densities in plots where no releases were made.
- Densities of European red mite (*Panonychus ulmi*) remained low in release plots even though miticides were not used.

These results indicate the strong potential for using *T. pyri* in HV and CV orchards to control European red mite. This will benefit the apple industry by providing a stable, effective, and nearly cost free mite management program.

Fire Blight of Apple Interstems and Rootstocks

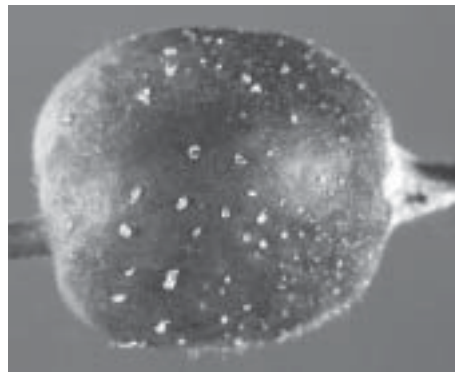
Herb Aldwinckle¹, Terence Robinson²,
and Gennaro Fazio³

¹Dept. of Plant Pathology,
Cornell University, Geneva, NY

²Dept. of Horticultural Sciences,
Cornell University, Geneva, NY

³Plant Genetics Resources Unit,
USDA/ARS, Geneva, NY

Fire blight usually first infects apple blossoms, damaging the crop, and later apple shoots, damaging the tree. In recent years, an even more devastating infection of the rootstock has occurred in New York orchards planted on M.9 and M.26 dwarfing rootstocks. We have



Fruit infected with fire blight showing droplets of ooze containing high concentrations of FB bacteria.

shown that rootstocks can become infected from infections of root suckers and through burrknots damaged by borers. But a third avenue of infection may be the most serious—the movement of fire blight bacteria downward inside healthy-appearing branches and trunks, from infected blossoms and shoot-tips into susceptible M.9 and M.26 rootstocks. We now have evidence that such movement can happen very quickly when blossom infections occur in trees, particularly those in their 3rd or 4th leaf. Pruning out infections to prevent spread into the rootstock has given varied results in different years. Thus, control of blossom infections (and of suckers and burrknots) is critical in young dwarf orchards. The dwarfing rootstock, B.9, and the new Geneva rootstocks, especially the dwarfing stock G.16, show great promise for reducing the problem because of their high resistance to fire blight, which has held up in two severe orchard trials. Apple trees grafted on B.9 and G.16 are available from several nurseries. Other fire blight resistant rootstocks will be re-

leased by the Geneva breeding program in the near future. Understanding how rootstock infection occurs and the development of strategies and resistant rootstocks to prevent it will greatly reduce tree losses in New York dwarf apple orchards.

Biology and Control of Fungi that Cause Apple Fruit Russet

Thomas J. Burr and Martin C. Goffinet²

¹Department of Plant Pathology,
Cornell University, Geneva, NY

²Department of Horticultural Sciences,
Cornell University, Geneva, NY

Russet occurs on many important apple cultivars in New York and results in reduction of fresh market quality of the fruit and therefore to grower profits. We have discovered that a common fungus, *Aureobasidium pullulans*, is prevalent on apple and is able to cause russet of fruit in New York orchards. Russet caused by the fungus often has characteristic black corky spots within the russeted region that is comprised of spores of the fungus. Although Golden Delicious is most prone to russet, other important cultivars were identified by growers as having significant russet in some years. Fungicides such as Captan, Polyram and, to some extent, Sovran are inhibitory to *A. pullulans*, and provide a significant level of control in orchard experiments. However, it was determined that some isolates of the fungus are reduced in their susceptibility to these fungicides. It is interesting that isolates recovered from plants that are not sprayed with fungicides were found to be the most sensitive to captan and Polyram suggesting that long term use of the fungicides has led to tolerance. Tolerance of some isolates may explain why complete control of russet has not been achieved in the orchard even following weekly sprays. *A. pullulans* is not sensitive to some fungicides, such as dodine and the sterol-inhibitor group. It has been possible to observe the effects *A. pullulans* has on fruit surfaces using microscopy. Fruit inoculated with the fungus show changes in surface cells within seven days. It was first observed that the fungus erodes the surface (wax and cuticle) and induces cell divisions in outer apple tissues that are associated with the classical wound response. Our evidence suggests that the fungus induces russet rapidly after reaching a certain population threshold. Identifying how the fungus causes russet may lead to the discovery of novel ways to control russet.

The Role of Epiphytic Bacteria in the Shoot Blight Phase of Fire Blight

Jaꝝ Norelli

USDA, ARS, Appalachian Fruit Research Station, Kearneysville, West Virginia

The purpose of the project is to determine if fire blight bacteria can multiply on the surface of apple leaves without causing disease (epiphytic). The long-term goal of the research is to identify the sources of fire blight bacteria that initiate the shoot blight phase of the disease. If fire blight bacteria are capable of growing epiphytically on apple shoots, these bacteria could serve as a source of bacteria for subsequent shoot infections and explain how shoot infection can sometimes seem to "appear from nowhere". Results indicate that fire blight bacteria do not multiply or survive on apple shoots without causing disease. Although bacteria can be detected on apple shoots after inoculation, it appears that the bacteria detected are associated with the direct infection of shoots and not with epiphytic survival. These results indicate that shoot blight infection should be associated with rain events and close proximity to infected material. They also support previous recommendations stressing the importance of pruning out fire blight cankers during dormant pruning and the importance of controlling blossom blight, since both active cankers and blossom infections would be obvious sources of bacteria for shoot inoculation.

Integrated Diagnosis and Management of Apple Replant Disease in New York Orchards

Ian Merwin¹, Terence Robinson², Steve Hojng³, Mike Fargione³, and Kevin Iungerman³

¹Department of Horticulture, Cornell University, Ithaca, NY

²Dept. of Horticultural Sciences, Cornell University, Geneva, NY

³Cornell Cooperative Extension

As growers renovate old orchards, apple replant disease (ARD) often becomes a serious problem. Chemical soil fumigation sometimes controls ARD, but fumigation responses have been variable and may be linked with environmental problems. Other possible control tactics for ARD include disease-suppressive preplant cover crops, correction of soil compaction, nutrient and pH problems, and disease resistant rootstocks. Six years ago, we began a project to test and develop comprehensive strategies for diagnosing

and controlling orchard replant problems. With funding support from New York apple growers, we tested methods for predicting the severity of ARD and biological or chemical strategies for controlling ARD at selected commercial apple orchards in the state's major fruit-growing regions. Soils from 17 orchards were sampled during 1996 to 1998 for nematode populations and nutrient status, and growth of apple seedlings or grafted rootstocks was compared in fumigated, pasteurized, and untreated field soil. At the same time, six or seven preplant soil treatments were evaluated at each orchard: 1) No treatment (Control); 2) Brassica/Sudan grass cover crops (B/S); 3) Lime and fertilizer amendments (L/F); 4) Lime and fertilizer plus Brassica/Sudan grass (LFB/S); 5) Lime and fertilizer plus Vapam fumigation (LFV); 6) Vapam soil drench; and 7) Telone C-17 soil fumigation. The following year, apple trees were planted into each preplant treatment, and, since then, we have measured tree growth, fruit yields, and nutrient uptake each year. The preplant bioassays indicated ARD problems at two-thirds of these orchards—seedlings or grafted trees grew much better in pasteurized or fumigated soil. Nematode populations were below damage thresholds at most sites.

In subsequent years, tree responses to the preplant treatments were inconsistent from farm to farm. Fruit yields varied up to five-fold among the orchards. At a few sites, trees responded positively to fumigation, while, at others, the best growth and yields occurred in fertilizer/cover crop treatments, or there was no significant benefit from any preplant treatment. The initial diagnostic bioassays over-predicted substantially the subsequent tree growth responses to soil fumigation in most orchards. These results indicate that preplant soil treatments can not guarantee good growth and early yields of apple trees. The many other factors that can limit replant success must also be managed correctly. Fruit growers can benefit from this research by considering preplant soil treatments as just one of many management practices essential for successful establishment of orchard replants.

Pesticide Application Technology Andrew Landers

Department of Entomology,
Cornell University, Geneva, NY

Correct pesticide application continues to be a major concern to all growers. Research activities have been based upon

the area of improving deposition and reducing drift. Often reducing drift by larger droplets doesn't necessarily improve deposition due to leaf run-off. Air induction nozzles fitted into air blast sprayers have been evaluated in a number of orchards and we have had great success at applying growth regulators and controlling disease. Insect control has been less successful. The nozzles are an inexpensive way of reducing drift and are extremely useful if growers are near watercourses or have close neighbors. Other work of interest to apple growers is the development of deflectors to target spray towards the canopy. This on-going project is funded by other outside bodies, but the results to date look most promising.

HARVEST and STORAGE QUALITY

Use of 1-Methylcyclopropene (1-MCP) for Control of Softening and Other Ripening Processes of New York-Grown Apples

Chris Watkins¹, Jackie Nock¹, Jim Wargo², Kevin Iungerman² and Mike Fargione²

¹Department of Horticulture, Cornell University, Ithaca, NY 14853

²Cornell Cooperative Extension

1-Methylcyclopropene (1-MCP) is an exciting postharvest chemical that will soon become available to fruit industries. Federal registration is expected in June 2002. 1-MCP, or SmartFresh™, as it will be known commercially, represents a potential revolution in our ability to store fruit and produce a better quality product in the marketplace. The chemical, which is released as a gas in storage rooms, inhibits the action of ethylene, the plant growth regulator that controls ripening of fruit such as the apple. The consequences of inhibiting ethylene action are to prevent or slow down softening, color change and other ripening related events. The New York industry relies on varieties that are particularly prone to softening, and we must exploit the effectiveness of 1-MCP.

The first two years of this project have involved a major undertaking to examine a range of variety, harvest maturity and postharvest handling operations that will affect the efficacy of the chemical for the New York industry. It is essential that we gain the knowledge that will allow initial use of 1-MCP with minimum risk. The experiments that have been completed or are still in storage include:

- A survey of the responses of most im-

- portant varieties to our industry.
- Effects of fruit maturity, especially for McIntosh and Empire.
 - Comparison of air and controlled atmosphere (CA) storage regimes.
 - Investigation of regional effects.
 - Comparison of warm versus cold treatment with 1-MCP.
 - Effect of storage temperature, e.g. can we store 1-MCP treated fruit at 38°F and eliminate chilling injury as a major storage risk for the New York industry.
 - The effect of delays after harvest before treatment with 1-MCP.

We have found, or are finding, answers to these questions. Initial results have been described at fruit schools, the Postharvest Handling Newsletter, and the Storage Workshop. It is now clear that responses of fruit to 1-MCP can vary greatly both in terms of varieties and where they are grown, that 1-MCP is not a substitute for long term CA storage for many varieties, and that varieties grown in some regions may be more responsive to 1-MCP than those grown on other regions. Fruit treated warm are often more responsive to 1-MCP than those treated cold, the latter method being the presumed commercial method of application. Such treatments raise handling issues that need to be resolved. Also, there is a failure rate with the chemical that is not always explained by internal ethylene concentrations. We need to develop a strategy to determine when fruit have not responded to the chemical.

Watkins, C.B., Nock, J.F. 2000. MCP: Facts, speculation, and how could it affect the NY apple industry? *New York Fruit Quarterly* 8 (3): 5-9.

Watkins, C.B., Nock, J.F. 2001. What do New York results tell us about the future of MCP. p79-96. In: *Storage Workshop 2001: Apple handling and Storage*. NRAES-153.

Several presentations have also been made at State-wide fruit schools.

Understanding the Soft Scald Problem in Honeycrisp

Chris Watkins¹, Jackie Nock¹, and Kevin A. Iungerman²

¹Department of Horticulture, Cornell University, Ithaca, NY

²Cornell Cooperative Extension

Honeycrisp is an exciting new variety that has generated enthusiasm among many New York growers. However, two types of physiological disorders, bitter pit and soft scald, have occurred in the marketplace and have the potential to destroy this promising apple. In this project, our focus has been on soft scald. The most serious aspects of soft scald to date have

been its sporadic nature, sometimes occurring after fruit has left the shipper, and that it can develop internally without any external symptoms. We have concluded from this two-year project, completed this year, that the following factors are important for soft scald control in Honeycrisp.

Harvest maturity and storage temperature: Soft scald development is clearly increased by exposure to storage temperatures of 33°F, especially in fruit from later harvest dates. In the first year, at the last harvest dates, even a higher storage temperature of 37°F did not control the disorder. In the second year, storage temperatures of 33, 38 and 42°F were tested. The highest temperature did reduce soft scald development in highly susceptible fruit, but a high decay incidence and less favorable sensory profiles make this temperature unacceptable for storage. Although advanced fruit maturity in some orchard blocks in mid-September was sometimes associated with soft scald development, no association with IEC was found for fruit harvest late. This study has not identified any single factor that is related to fruit susceptibility to soft scald, and a project to be initiated this harvest season aims to develop harvest indices for the variety.

Postharvest treatments: A holding period at 50°F of a week prior to cold storage markedly reduces soft scald development. Informal tasting of fruit does not suggest that Honeycrisp quality is deleteriously affected by this treatment, and we are aware of two growers who have applied this method with good results. However, both warmer storage temperatures, as well as delay treatments, enhance bitter pit incidence. Therefore, bitter pit susceptibility is the major issue that needs to be resolved for the Honeycrisp variety if soft scald is to be controlled satisfactorily. The major recommendations from this work are that fruit should be harvested as soon as appropriate color and flavor have been obtained and that a storage temperature of 38°F is recommended. Storage operators need to find a way to ensure that a dedicated room is available, especially as crop volume increases.

Rosenberger, D., J. Schupp, C. Watkins, K Iungerman, S. Hoying, D. Straub, and L. Cheng. 2001. *Honeycrisp: promising profit maker or just another problem child?* *NY Fruit Quarterly* 9(3):9-13.

Watkins, C.B., Nock, J.F., and Iungerman, K., 2001. *Understanding the soft scald problem in Honeycrisp*. Pages 9-20. In: *Apple Handling and Storage: Proc. Storage Workshop 2001, Cornell University, Ithaca. Natural Resource, Agriculture, and Engineering Service (NRAES) Publication 153, Cornell University, Ithaca, NY. 130 p.*

Effects of Foliar Applications of Calcium, Boron, and Flint Fungicide on Incidence of Bitter Pit

David Rosenberger¹, Jim Schupp², Chris Watkins³, Steve Hoying⁴, and Lailiang Cheng³,

¹Department of Plant Pathology, Cornell University, Highland, NY

²Dept. of Horticultural Sciences, Cornell University, Highland, NY

³Department of Horticulture, Cornell University, Ithaca, NY

⁴Cornell Cooperative Extension

Objectives of this project were to compare effectiveness of foliar sprays of calcium, boron, and Flint fungicide for reducing bitter pit and to evaluate interactions among the three products. Replicated plots were established in Honeycrisp apple orchards in the Hudson Valley and in Western New York. In five trials conducted over two years, Flint fungicide significantly reduced the incidence of bitter pit at harvest in only one trial, and the bitter pit suppression provided by Flint disappeared when apples were evaluated after several months of cold storage. Calcium chloride (CaCl₂) sprays also failed to control bitter pit in 2000 when they were applied only three times during summer using low rates (equivalent to a total of 0.9-lb actual calcium per 100 gal of dilute spray). In 2001, however, CaCl₂ sprays provided good control of bitter pit in the Hudson Valley trial when six applications were made during summer (June through August) with rates adjusted to provide a seasonal total of 3 lb of actual calcium per 100 gal of dilute spray. At harvest, Honeycrisp from Ulster County trees that were treated with CaCl₂ had only 2% of fruit with bitter pit compared to 9% in fruit from non-treated trees. After 47 days of cold storage at 37°F, the percentage of fruit downgraded because of bitter pit had increased to 25% for fruit sprayed with CaCl₂ compared to 67% for control fruit. Even the best treatments in this trial had a high incidence of bitter pit because trees in the test orchard had a light crop, the fruit were harvested slightly immature, and the 37°F. storage temperature favored continued development of bitter pit after harvest. Combining Flint fungicide, Solubor sprays, or Messenger (harpin protein) with CaCl₂ did not enhance the effectiveness of the CaCl₂ sprays. In Western New York, commercial formulations of calcium that, when applied according to the label, totaled 3 lb of actual calcium per 100 gal of dilute spray, provided 80-90% control of bitter pit in fruit that were rated after 90

days of cold storage plus 7 days at room temperature. In treatments where total calcium applied during the season ranged from 1.8-2.2 lb or actual calcium, control of bitter pit ranged from 36-63%. Results of this trial showed that bitter pit in Honeycrisp is best controlled by applying high rates of CaCl₂ throughout summer. However, CaCl₂ sprays alone will not completely control bitter pit if other factors predispose fruit to severe bitter pit.

Therefore, controlling bitter pit on a highly-susceptible apple cultivar such as Honeycrisp will require an integrated program of CaCl₂ sprays, crop load and fertility management, and attention to harvesting fruit at optimum maturity and storing them at temperatures that minimize both bitter pit and other storage disorders such as soft scald.

Rosenberger, D., Schupp, J., Watkins, C., Iungerman, K., Hoying, S., Straub, D., and Cheng, L. 2001.

Honeycrisp: promising profit maker or just another problem child? NY Fruit Quarterly 9(3):9-13.

Schupp, J., Straub, R., Rosenberger, D., and Watkins, C. 2001. *Managing Honeycrisp for production and quality.* Compact Fruit Tree 34:107-109.

Schupp, J. R., Rosenberger, D. A., Watkins, C. B., Cheng, L., and Hoying, S.A. 2001. *Understanding the bitter pit problem in Honeycrisp.* Pages 1-8 in: *Apple Handling and Storage: Proc. Storage Workshop 2001, Cornell University, Ithaca.* Natural Resource, Agriculture, and Engineering Service (NRAES) Publication 153, Cornell University, Ithaca, NY. 130 p.

ARDP Funded Projects - 2002

RESEARCHER	TITLE	ARDP AWARD	ARRA AWARD
Aldwinckle, Robinson, Fazio	Fire Blight of Interstems and Rootstocks	8,580	
Aldwinckle	Improvement of NY Apple Varieties & Rootstocks by Biotechnology Techniques	15,000	
Amisshah, Hotchkiss, Watkins	Processing Apple Slices for Long Shelf Life	3,000	
Brown, Maloney	Assessing the Commercial Potential of Advanced Apple Selections & New Varieties of Interest	8,900	8,000
Burr, Goffinet	Biology & Control of Fungi That Cause Apple Fruit Russet	4,000	
Cheng, Schupp, Merwin, Watkins	Comparing Foliar Nitrogen with Soil Applied Nitrogen on Apple Yield, Fruit Quality, & Tree Cold Hardiness	8,000	
Koeller, Turechek	Simplified Testing of fungicide Resistance in Commercial Apple Orchards	7,700	
Lakso, Robinson, Cheng, Eissenstat, Fazio	Seasonal Patterns of Root Growth & Lifespan in Dwarfing Rootstocks in NY	10,830	
Landers, Barber	Development of a Method for Measuring Pesticide Deposits in Apple Trees	12,000	
Liu	Role of New York Apples in the Prevention of Cancer	10,000	
Norelli	The Shoot Blight Phase of Fire Blight	5,000	
Nyrop, Iungerman, Jentsch, Straub	Biological Mite Control in Hudson and Champlain Valley Apple Orchards Through the Distribution and Conservation of <i>T. Pyri</i>	3,920	
Reissig, Nyrop	Monitoring the Effects of Newer "Soft Insecticides" Against Parasites of the Oblique-Banded Leafroller	4,590	
Robinson, Agnello, Carroll, et al	Development of an Integrated Fruit Production (IFP) Protocol for NY Apples	6,000	
Robinson, Lakso, Cheng, Valencia	Maximizing the Performance of Young Apple Trees	11,500	
Robinson, Hoying, Fargione, Iungerman	Orchard Management Systems for Improved Yield & Fruit Quality	20,000	8,000
Schupp, Robinson	Development of Chemical Thinner Alternatives	8,000	
Watkins, Wargo	Maturity & Quality of Honeycrisp	7,500	
Watkins, Nock, Hoying, et al	Use of 1-methylcyclopropene (1-MCP) for Control of Softening & Other Ripening Processes of New York-Grown Apples	19,550	
Total		174,070	16,000

Preventing Postharvest Decays of Apple Fruit

David Rosenberger¹, Jim Schupp² and Terence Robinson²

¹Departments of Plant Pathology, Cornell University, Highland, NY

²Dept. of Horticultural Sciences, Cornell University, Highland, NY, and Geneva, NY

Objectives of this project were to determine: 1) if boron concentrations in apple fruit affect fruit susceptibility to decay during storage; and 2) how inoculum of *Penicillium expansum*, the fungus that causes most postharvest decays, cycles from one year to the next. Different boron fertilizer regimes were applied to replicate plots in orchards at Geneva and Highland. Fruit from these plots were harvested at normal maturity and were inoculated by placing a drop of a spore suspension of *P. expansum* on the ends of the fruit stems. The inoculated fruit were then moved to long-term controlled atmosphere (CA) storage and were evaluated for decay after nine months of CA storage. Results from the first year confirmed that high boron concentrations increase susceptibility of fruit to invasion by *P. expansum* through stems. The incidence of decay in Empire fruit from untreated trees (no added boron) in the Highland experiment was 20%, and fruit had 24 and 11 ppm boron in leaves and fruit, respectively. For trees given moderate boron treatments, the comparable numbers were 38% decay for fruit with 31 and 24 ppm boron. Trees with high boron fertilization (including soil-applied boron) also had 38% decay, but leaf and fruit concentrations of boron were 39 and 38 ppm, respectively. Similar results occurred with Delicious fruit taken from the same treated plots. Under the second objective, spore trapping in three packinghouses over a two-year period showed that spore density in packinghouse air often exceeded 150 spores per liter during late winter. At the high spore densities measured in packinghouse air, spores can settle onto bins in the packinghouse at a rate of more than 1 million spores per bin per hour, thereby contaminating bins with inoculum that will remain viable until bins are re-used the following year. The airborne spores also contaminate fruit on the packing line and contribute to the high incidence of decays noted in retail apple displays during two years of store surveys. Results from these trials show that growers can reduce fruit susceptibility to decay by avoiding excessive boron fertilization. However, better sanitation is needed in packinghouses to reduce airborne inocu-

lum that contaminates fruit being packed and that contributes to inoculum recycling on bins.

Rosenberger, D. A. 2001. Decay and quality problems at the retail level. Pages 21-23 in: *Apple Handling and Storage: Proc. Storage Workshop 2001*, Cornell University, Ithaca. Natural Resource, Agriculture, and Engineering Service (NRAES) Publication 153, Cornell University, Ithaca, NY. 130 p.

Rosenberger, D. A. 2001. Postharvest decay control without fungicides. Pages 21-23 in: *Apple Handling and Storage: Proc. Storage Workshop 2001*, Cornell University, Ithaca. Natural Resource, Agriculture, and Engineering Service (NRAES) Publication 153, Cornell University, Ithaca, NY. 130 p.

Rosenberger, D. 2001. Postharvest pathogens create problems for storage. *The Fruit Grower News* 40(6):40-41.

Rosenberger, D. 2001. Sanitation methods for apple packinghouses explored. *The Fruit Grower News* 40(6):42-43.

Rosenberger, D., Meyer, F., and Ahlers, C. 2000. Progress in understanding and controlling postharvest decays of apples. *N.Y. Fruit Quarterly* 8(3):24-28.

HEALTH BENEFITS of APPLES

Antioxidant and Antiproliferative Activities of Selected New York Apple Cultivars

Rui Hai Liu¹, Marian V. Eberhardt¹, and Chang Yong Lee²

¹Department of Food Science, Cornell University, Ithaca, NY

²Department of Food Science and Technology, Cornell University, Geneva, NY

Diets rich in fruits and vegetables have been associated with lower incidences in cancer and lower mortality from coronary heart disease. Antioxidants in fruits and vegetables are thought to reduce cancer rates by counteracting the prooxidant load of the body. In addition to the presence of vitamins C and E, fruits and vegetables are a rich source of other antioxidants such as phenolic acids and flavonoids. We measured the total antioxidant activity of several apples varieties by Total Oxyradical Scavenging Capacity (TOSC) expressed as mmol vitamin C equivalents per gram. We found that all varieties of apples that we tested exhibited great antioxidant activity. Apples with the skin had higher antioxidant activity than apples without skin. Apple skins are known to contain higher amounts of phenolic compounds than the flesh. Others have reported that the amount of phenolics in the skin of apples is several times higher than that of the flesh and that the quercetin glycosides (the most predominate flavonoid in apples) are only found in the skin. Although apples have a relatively low Vitamin C content (which is one of the better known antioxidants), they do contain relatively high amounts of other



Apples are high in antioxidants which help prevent cancer.

antioxidants. The Vitamin C in apples accounts for only 0.4% of total antioxidant activity. Therefore, the majority of antioxidant activity of apple is not from Vitamin C, but from other phytochemicals in apples. The combination of different phytochemicals in apples may function additively or synergistically to be responsible for this potent antioxidant activity.

Apple extracts from selected apple varieties were added to human liver cancer HepG2 cells to determine if the extracts could inhibit tumor cell proliferation. There was a large variation in the effects of the different apple varieties on the inhibition of cell proliferation, but all apple varieties inhibited liver cancer cell proliferation. Apples without skin were less potent in inhibiting HepG2 cell proliferation whereas apples with skins exerted greater inhibitions of cell proliferation. Our results show that the combination of phytochemicals in apples is critical to its potent antioxidant activity and antiproliferative activity. Apple with the skin displayed higher antioxidant and antiproliferative activities than apple without skin. The total phenolic and flavonoid content was positively related to antioxidant activity and inhibition of cell proliferation. Additionally, the minimal contribution of Vitamin C to the antioxidant activity of apples further supports the proposal that other phytochemicals, such as phenolic acids and flavonoids, significantly contribute to the in vitro antioxidant activity of apples. This data provides direct supportive evidence for the Five-a-Day program, and suggests that apples are a good way for consumers to obtain their antioxidants for health improvement and disease prevention.

Terence Robinson is an Associate Professor of Pomology in the Horticultural Sciences Department.

Apple Cultivars: A Geneva Perspective

Susan Brown and Kevin Maloney

Department of Horticultural Sciences, Cornell University,
New York State Agricultural Experiment Station, Geneva, NY

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Funding from the New York Apple Research and Development program (ARDP) and the New York Apple Association (NYAA) aids our evaluation research on the performance of new cultivars and breeding selections. This article features some of the cultivars we have evaluated and offers information on other cultivars that are either not available for testing or are not recommended for our region, particularly in regard to having too long a growing season requirement. Selections from the Cornell program will be featured in a subsequent article. Growers interested in additional information on any of the cultivars listed are encouraged to contact the authors or to access the US Patent and Trademark Office at <http://patents.cnidr.org/access/search-bool.html/>. A search using "apple tree", the patent number, or the cultivar name provides access to a summary or a full text version of the patent application. The home page is at <http://www.uspto.gov/>

Information on cultivars being tested as part of the NE183 regional project, "Multidisciplinary evaluation of new apple cultivars" is available at the virtual orchard website (<http://www.virtualorchard.net/NE183/>). The 1995 and 1999 plantings were established at Geneva, Ithaca and Highland, NY. The

Highland site is for assessment of disease and pest susceptibility. The 1995 planting includes the following varieties and advanced selections: 'Arlet', 'Braeburn' (control), 'Creston', 'Cameo', 'Enterprise', 'Fortune', 'Fuji' (BC#2), 'Yataka Fuji' (control), 'Gala Supreme', 'Ginger Gold', 'Golden Delicious' (control), 'Golden Supreme', 'Goldrush', 'Honeycrisp', NY 75414-1, 'Orin', 'Pristine', 'Sansa', 'Shizuka', 'Suncrisp' and 'Sunrise'. Information on the performance of these cultivars was reviewed in the *Fruit Quarterly* (Brown et al., 1999). The 1999 NE183 planting features: 'Ambrosia', 'Autumn Gold', BC 8S-26-50, 'Chinook', 'Sundancer' (Coop 29), Coop 39, CQR 10-T17, CQR 12-T50, 'Delblush', 'Jubilee Fuji', 'Hampshire', NJ 90, NJ 109, NY 79507-49, NY 79507-72, 'Pink Lady', 'Pinova', 'Runkel', 'Silken' and 'Zestar'. 'Golden Delicious' ('Gibson') was the control cultivar.

'Ambrosia' ('Mennells Ambrosia'): (USPP#10,789). A chance seedling discovered in the 1980s in Cawston, British Columbia in an area where both 'Delicious' and 'Golden Delicious' trees were growing. The name 'Ambrosia' was chosen to denote its unique, honey-like flavor. 'Ambrosia's shape, appearance and harvest are similar to 'Delicious', but

The newer apple cultivars that we recommend for careful testing by growers in New York include 'Ambrosia', 'Braeburn', 'Corail', 'Sansa', and 'Zestar'. Other apples discussed in this article may also have limited opportunities depending on the grower's market and customer acceptance.

the fruits are slightly square. It has been described as very attractive, of good size, crisp, sweet, low acid, very juicy, distinct but mild, with a pleasant aroma. It has been rated well in test trials. Trees are productive, upright, spur-type and grower friendly. Trees should not be overcropped early. Two harvests are recommended. The high sugar content can cause splitting following autumn rains. Storage life is reported to be four months in 0°C air and six months in C.A. 'Ambrosia' was reported to have a slight tendency to sunburn. Fruits have a pink/red blush on a cream/yellow background, with exposed fruits coloring 70 to 80 percent. There are some indications that 'Ambrosia' is very site specific.

'Ambrosia' was harvested on 10/15/01 in Geneva. Fruits have 50 to 80 percent dull orangish pink/red on yellow and are oblate to conic in shape with slight lobing.



'Arlet'



'Braeburn'



'Creston'

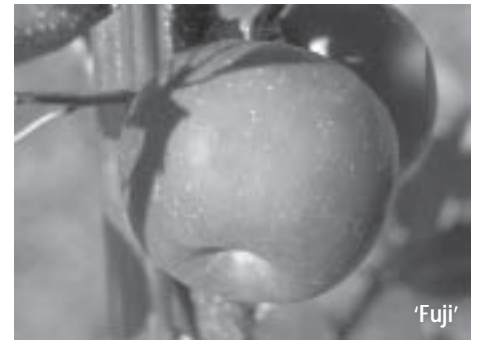
Fruits have long stems and an open calyx. They were judged as still crisp and firm after storage to mid-December and after a 7-day shelf life test, but had little flavor or a slightly musty flavor. Fruits were 12.5% Brix and 17-18 pounds firmness just after storage. No storage disorders were noted other than one occurrence of brown core. 'Ambrosia's texture, firmness, storage life (except for some greasiness) and high pack-outs are all strengths, but the mild flavor may be a negative if it is considered to be too bland. Limited test planting is recommended for those who have a market for mild flavored yet crisp apples.

'Arlet' ('Swiss Gourmet'): (USPP#6,689). 'Arlet's good quality is no match for poor appearance due to russetting. Not recommended for trial.

'Autumn Gold'™ ('Hein'): (USPP#9,907) A chance seedling discovered in Tieton, Washington in 1985. It is a late maturing 'Golden Delicious' type with an attractive red blush on a yellow/green ground. 'Autumn Gold' matures about two weeks later than 'Golden Delicious'. Fruit size and shape are reported to be uniform and fruits are not prone to russetting. It is said to have better than average storage life when compared to other Golden's. The tree is of medium vigor with spreading branches.

Fruits were prone to russetting at Geneva in 2000. 'Autumn Gold' was harvested on 10/10/01 and found to pick hard. Fruits had an attractive appearance, being 30 percent salmon colored blush on green, with slight russet in the stem cavity and some on the lenticels. Fruits have long stems but are difficult to harvest. The calyx was open on some fruits (and closed on others). Fruits did not store well for quality, had thick skins and were chalky and mild. No storage disorders were noted.

BC 8S-26-50. A hybrid of 'Gala' x 'Splendour' developed in Summerland, British Columbia. It ripens one week after 'Delicious'. It has been in advanced trials in Canada since 1990. At Geneva, this selection was harvested on 10/25/01. Fruit appearance was very poor, with extensive russet and some cracking. Fruits were a dull, pale reddish-brown, and some were irregular in shape. Following storage, BC 8S-26-50 was still crisp and slightly juicy, but some fruit shrivel occurred. Many rots developed in storage, with some fruits having slight brown core. BC 8S-26-50 is not recommended for trial due to russetting, poor fruit appearance and susceptibility to storage rots.



BRAEBURN

'Braeburn': Although a challenging variety to grow, its excellent quality following storage and its ability to retain firmness on the shelf are reasons to give this cultivar a test. Sports include:

'Braestar'™ ('Brayleet'): Limb mutation of 'Braeburn' discovered in Havelock North, New Zealand. Redder color and ripens 3 to 5 days earlier than standard 'Braeburn'.

'Joburn'™ Braeburn' ('Aurora'): (USPP#11,992). Sport of standard 'Braeburn' discovered in New Zealand.

'Eve'™ Braeburn': (USPP#11,604). Natural mutation of 'Braeburn' discovered in New Zealand with 90 to 100% red blush. Reported to have a slightly later maturity than standard 'Braeburn'.

'Kumeu Crimson Braeburn': A new listing that is not yet in the patent database.

'Lochbuie Braeburn': (USPP#11,266). A highly colored blushed sport of 'Braeburn' discovered in New Zealand. Distinct in that it does not have the standard stripe and fleck, but instead is a blush.

'Mariri Red': (USPP#11,604). A limb mutation of standard 'Braeburn' discovered in New Zealand. The dark red coloration is nearly 100 percent and it is a solid blush type.

'Rocket Red'™ Braeburn': (USPPAF). A sport of standard 'Braeburn' discovered in New Zealand that is distinct in having a very intense blush and narrow and intense stripes. All other characteristics are the same as standard.

'Cameo' ('Caudle'): (USPP#9,068). This cultivar offers mild flavor, good storage and good crispness. Its appearance is similar to 'Hawkeye', the original 'Delicious'. 'Cameo' sets five fruits per cluster, so overcropping is a concern especially to prevent biennial bearing. The flavor on young bearing trees is poor, but improves as the trees

age. Young trees are susceptible to bitter pit.

'Chinook' (8S-27-51):(USPP# 10,740). A 1998 release from Summerland, British Columbia (Quamme et al., 1999). It is a hybrid of 'Splendour' x 'Gala' that was selected for its firmness, crispness and quality. Fruits are 80 to 90 percent bright red on yellow and have excellent appearance, texture, quality and storage attributes. It is harvested about 5 days after 'Delicious'. Over 3,000 trees of 'Chinook' have been planted in Canada. Skin and stem bowl russet, skin shrivel, and moldy core have been reported.

'Chinook' tends to overset. Fruit size has been very small at Geneva even after thinning. Fruits are pale brownish red and 2.5 inches or less in size. Fruits have prominent lenticels and the fruit russet resembles scarf skin. Some fruit cracking was observed. After storage, 'Chinook' was still crisp, firm and sweet. In 2001, fruits were free from storage disorders. Only growers willing to gamble on their ability to thin 'Chinook' should test plant this variety. It appears to be worse than 'Gala' in having a genetic tendency towards heavy cropping and small fruit size.

'Corail'™ (formerly 'Pinova') (Pia 11, 24). (USPP#11, 601). A hybrid of ('Duchess of Oldenberg' x Cox's Orange Pippin) x 'Golden Delicious' that was introduced by the Fruit Research Institute in Dresden, Germany, in 1986. 'Corail' has a spicy flavor and fruits are small to medium in size. 'Corail' is reported to have outstanding flavor, matures with 'Golden Delicious', medium size, fluorescent pinkish-red, very productive; crops regularly every year. The medium to low vigor may necessitate a more vigorous rootstock than M.9. Its susceptibility to diseases is similar to that of 'Golden Delicious'. Initial tests in Europe suggest this variety might have good market acceptance and some resistance to winter and spring frosts.

Preliminary tests at Geneva indicate



that 'Corail' may be prone to necrotic leaf blotch and fruits may develop soft scald. Trees are very precocious. 'Corail' was harvested on 10/5/01 in Geneva. Some fruits had extensive russet and fruit acidity is high (0.45). The skin is aromatic, but some testers considered it astringent. Fruits had 12 + seeds and also very long stems. The cream flesh was still crisp but becoming soft after storage until January, yet they were still slightly spicy. Fruits held up well, with only slight shrivel following storage. Limited test planting is recommended due to quality, productivity and prospects for hardiness, but growers need to assess the size potential and tendency towards soft scald development under their conditions.

'Creston': (USPP#10,739). Its similarity to 'Jonagold' in being a triploid, having poor coloration, and fruit that softens and gets greasy in storage are disadvantages.

'Delblush'™ (USPP#10, 276). A hybrid of 'Golden Delicious' x 'Blushing Golden' (cv. 'Grifer') developed by the Delbard Nursery in France. The patent states that the attractive fruits are of excellent flavor and texture, and that the orange blush is dependent on adequate sun exposure. The flesh of the fruit resists browning. The harvest time is mid- to late-season (about one to two weeks after 'Golden Delicious') and the storage life is good. 'Delblush' is being marketed through a club, with growers licensed and paying a production-based royalty. Lenticel russet has been observed in Washington State. 'Delblush' is susceptible to storage scald.

'Delblush' was harvested on 10/19/01 in Geneva. While the quality is very good, the appearance can be quite poor due to russetting. The slightly oblong fruits had 40 percent orange red blush, long stems and a slightly open calyx. Fruits were still crisp and slightly spicy just after storage with 16.6% Brix and 17 to 21 pounds firmness. Fruit acidity was high. Some shriveling was observed in storage. In 2001, russet was less than in

2000, with only a few fruits with extensive russet and cracking. Some fruits had an off-flavor but were still firm and crisp. Sectors of color and russet were evident on some fruits. Test planting is recommended due to the good fruit quality, but only if russet can be managed by site selection or by the use of appropriate cultural methods or sprays.

'Fortune': (USPP#11,000). This hybrid of 'Empire' x 'Schoharie Spy' has some of the 'Spy' problems: large fruit and tree size, bitter pit and biennial bearing, but still is of interest as a true dual use variety that has some of the 'Spy' spiciness and quality.

'FUJI': New Sports

Some of the older sports of 'Fuji' include: BC #2, Naga-fu 2, 6, and 12, Aki-fu #1, 'Seiko-fu Red Fuji', 'Red Fuji T.A.C. 114' (USPP#8,032) and 'Yataka' (USPP#7,001). Newer sports include:

'Autumn Rose Fuji': (USPPAF). A whole tree 'Fuji' mutation discovered in Oregon. Reported to have 90 to 100 percent red color without the muddiness typically associated with 'Fuji'. Striping is similar to Nagafu 12.

'Auvil Early Fuji'™ ('Fuji 216'): (USPP#10,141). In Washington, this sport was harvested the first week of September, several weeks ahead of standard 'Fuji'.

'Beni Shogun Fuji': (USPP#7,997). Originated in Japan in 1988. Exposed fruits have an overall pinkish color.

'Blaze'™ Fuji: (USPPAF). A sport of 'Nagafu 6' that shows blush and stripes on the back of the fruit. 'Blaze Fuji' is bright pink, not the liver color of some sports.

'Coe Fuji' ('Ebbourcoe'): (USPPAF). Discovered as a whole tree sport of B.C. Fuji in Washington. Has a solid red blush.

'Desert Rose Fuji': (USPPAF). A whole tree mutation of 'Fuji' discovered in Washington. Fruit color is 80 to 100 percent reddish/pink. Chosen for its excellent blush and coloration in shaded areas of the tree.

'Fuji Lynd Spur' ('Fuji Spike'): (USPP#9,508). A mutation of 'Fuji' with a spur type and semi-growth habit discovered in Ohio by Mitch Lynd.

'Myra Fuji': (USPP#9,645). Pinkish red color that extends over the entire fruit surface and overlain with slightly darker, pink-red stripes. 'Myra Fuji' is earlier coloring and earlier maturing.

'September Wonder'™ Fuji (Formerly 'Jubilee Fuji'™ ('Fiero')): (USPP#11,193). Discovered as a whole tree mutation of an early 'Fuji'. Reported to mature 30 to 40 days earlier than standard 'Fuji', to have typical 'Fuji' flavor, but keeping qualities similar to 'Gala'. Fruits were harvested on 9/19/01 in Geneva and were very pale, brownish-pink and of poor quality. Fruits had a closed calyx and not much russet. After storage until December, fruits were found to have slight brown core, very bad off flavor and undesirable texture. This sport should be marketed early and not stored late, if grown at all.

'Sun Fuji': Reported to color earlier and more fully.

'Topexport'® Fuji ('Snyder'): (USPP#12,098). A sport of 'BC#2 Fuji' discovered by C&O Nursery. Selected for its deep color and heavy stripes.

'Triple E Fuji' ('Torres Fuji'): (USPPP# 12,219). This sport is characterized by fruit almost solid red in color with no striping. It matures earlier than BC#2.

'GALA': New Sports:

The interest in new and improved sports of 'Gala' is all too reminiscent of 'Delicious'. As we increase color, we may be lessening the characteristic aroma and quality. Also as color increases, so does the prevalence of stem cavity and shoulder russet and scarf skin. Darker sports may bear little resemblance to 'Gala' and should be avoided.

'Autumn Gala' ('Harry Black'): (USPPAF). Discovered in Maryland, it is reported to ripen 5 to 6 weeks later than 'Gala' and is 18-23 pounds at harvest.

'Big Red Gala': (USPP #10,458). Discovered in Indiana as a limb sport of 'Gala'. Distinct in its larger fruit size, attractive medium red blush, larger leaves and rounder fruit than standard 'Gala'.

'Brookfield Gala' ('Baigent'): (USPP#10,016). Discovered in New Zealand. Reported to have a bold red stripe over a red background.

'Buckeye'® Gala ('Simmons'): (USPP#10,840). A sport of 'Imperial Gala' discovered in Ohio. Reported to have 100

percent red with an understripe. In Geneva, the fruit coloration was too dark and there was extensive scarf skin and shoulder russetting.

'Crimson® Gala' ('Waliser'): (USPP#8,673). Early coloring blush type, but lesser colored fruits show light red pinstripes.

'Gale Gala®' ('Malaga'): (USPP# 10, 114). A whole tree sport of 'Tenroy Gala' (USPP #4,121) discovered in Washington. 'Gale Gala' is reported to be a one- or two-pick 'Gala'. Fruit have 90 to 100 percent full red color with deep red striping

'Grand Galaxy™' ('Caitlin'): (USPPAF). Discovered as a partial tree mutation of 'Royal Gala' in Tennessee. Fruit size is stated to exceed that of the parent on the original mutation by 50 percent. Trees may bloom, and fruits may mature slightly earlier than 'Royal Gala'.

'Magnum® Gala' ('Stiekema 1'): (USPP#11,182). In comparison to Otagala, fruit is significantly larger, with a deeper, wider cavity. Stems are longer and thicker. There is intense red coloration on 90 to 100 percent of the fruit. Young leaves are bronze in color. Trees are slightly less vigorous, with smaller leaves and thinner branches that tend to terminate sooner.

'Pacific Gala™' ('Olsentwo'): (USPP#9,681). A whole tree mutation of 'Royal Gala' that is reported to have earlier coloring, an earlier harvest, and requires fewer picks.

'Twin Bee Gala': A sport of 'Royal Gala' that has early uniform color and pronounced stripes.

'Ultima Gala': (USPPAF). A limb mutation of 'Imperial Gala' discovered in Washington that has 95-100 percent red color with a strong stripe.

'Ultrared Gala' ('Otagala'): (USPP#8,621). Solid nopal red coloration over 90 to 100 percent of the fruit. Fruits of lower color intensity show hints of striping.

'Gala Supreme': Not a sport of 'Gala' as is commonly believed. Fruits are very oblate and can get very greasy. Not recommended for trial in New York.

'Ginger Gold': (USPP#7,063). Fruit have good quality for the early market, but price premiums have declined.

'Golden Delicious' Strains: A non-russetting 'Golden Delicious' type is still being sought for New York. 'Golden Delicious' demonstration plantings were established in commercial orchards and in cooperation with processors in New York in 1998. 'Golden Delicious' was the

control. Cultivars tested included: 'Smoothie Golden Delicious' ('Gibson'), 'Autumn Gold', 'Elliot', 'Golden Glory', 'Golden Supreme', Goldrush', 'Shizuka', Stark Ultragold' and 'Sun crisp'. These trials will provide additional information from commercial sites.

'Golden Supreme': A very attractive and aromatic 'Golden Delicious' type that is often of low productivity. Poor pollination may be the cause. It is not recommended for trial, but its productivity in the demonstration plantings will be evaluated.

'Hampshire' ('Gould'): (USPP #8,519). A chance seedling found in a 'Delicious' block in New Hampshire in the late 1980s.

'Hampshire' ripens with 'Empire' or early sports of 'Delicious'. It has a semi-spur growth habit. Fruits are very attractive with 90 to 100 percent burgundy red color with little or no striping. 'Hampshire' is reported to be very precocious and productive. It is not as sensitive to high temperatures as 'McIntosh'.

Harvested on 10/22/01 in Geneva. It is 95 percent dull burgundy on green. Some surface russet and stem and shoulder russet. 'Hampshire' often has high sugar levels, good firmness and good storage, but can have off flavors, some stem end cracks and open calyx, some skin cracks and weather checking. 'Hampshire' may work for niche markets in the late season, but its appearance is too similar to 'Empire' to be distinctive.

'Honeycrisp': (USPP#7,197). This cultivar continues to generate great interest and great challenges. Our program identified its susceptibility to soft scald prior to its increase commercially and cautioned growers about this problem, its poor coloration, bitter pit and mild flavor. Its texture, crispness and juiciness and storage attributes are strengths. Its crispness and juiciness are superior to most cultivars. Consumer acceptance has been outstanding. Rosenberger et al. (2001) reviewed research in New York and the IDFTA (International Dwarf Fruit Tree Association) dedicated an entire volume of the *Compact Fruit Tree Journal* (Volume 34-October, 2001) to researcher, grower, and marketer perspectives on this cultivar.

'JONAGOLD': New Sports

The Jonagold bulletin (Brown, 1997) highlighted some of the earliest sports: 'Jonagored' (USPP #5,937), 'Jonica' (USPP# 7,146), 'Rubinstar' (USPP#7,590)



'Sun crisp'



'Shizuka'

and 'DeCoster Jonagold' (USPP #8,049) and 'Nicolai's King Jonagold' (USPP# 8,851). The 'Jonagold' demonstration plantings in New York will add to our information on some of these sports.

'Excel': (USPP#10,314). A sport of 'Jonagold' has better color intensity over 50 percent or more of the surface. The fruit has a higher acidity and a longer and thinner stem. Faint stripes are barely visible.

'Jonagold' ('Romagold'): (USPP #9,541). A limb sport mutation of 'Jonagold' discovered in 1983. Fruits are early coloring, with a broadly striped color pattern of bright red stripes on a yellow ground.

'Morren's Jonagored Supra': (USPP #10,401). Reported to differ from standard 'Jonagored' by better coloring and ripening seven days earlier and the trees are less vigorous.

'Red Jonaprince': (USPP #11,112): Fruits are bright to dark red, non-greasy and very early ripening (four to five weeks earlier than standard 'Jonagold'). Reported to have firmer flesh that has more sugar and more acid than standard 'Jonagold'.

'McINTOSH' Sports

'LindaMac': Fruits start coloring in



early July and have 100 percent red blush at harvest. 'LindaMac' was discovered in Michigan as a sport of 'Redmax' and is said to be a typical 'McIntosh' in all other respects.

Other new releases include 'Miracle Mac' from Connecticut and 'Gunny Mac' (not the official name), a new sport discovered by the Gunnisons at Crown Point, NY, in the Champlain Valley.

'Scotian Spur McIntosh': (USPP#10,770). This is a spur type 'McIntosh' with a solid blush. The tree is about 60 percent the size of non-spur 'McIntosh'.

NJ 90: This selection is being tested as a highly colored alternative to 'McIntosh' in warmer regions. It is a hybrid of (NJ 15 x 'Red Melba') x 'Spartan'. Notes from the Pacific Northwest Fruit Testers Association indicate it is "fatally flawed with many faults, with a skin as thick as leather" (2/2000).

NJ 90 was harvested on 10/12/01 in Geneva. Fruits are oblate, slightly lobed, 90 to 95 percent burgundy on green. The skin thickness is objectionable. In January, it was at the end of its storage life, but holds up okay. Fruits have a short stem, a deep closed calyx and fruit size is large. NJ 90's similarity to 'McIntosh' and 'Empire' could cause marketing problems. While NJ 90 offers better fruit color, the quality suffers. NJ 90 was subject to preharvest drop at many of the NE183 sites in 2001. Not recommended for trial.

NJ 109: A hybrid of 'Golden Delicious' x NJ 88 from Rutgers

University. NJ 109 ripens 3 weeks before 'Golden Delicious', is very productive and crops annually. Fruits are much less prone to russet than 'Golden Delicious', but are susceptible to bruising. Reports on fruit quality has varied from fair to good. NJ 109 may not store very well.

Fruits were harvested in mid-September and were very susceptible to doubling at Geneva in 2001. Fruits are conic and slightly lopsided. The surface is clear yellow with almost no russet on the body and very slight russet on the cavity and shoulder. Fruits may have 5 to 10 percent pink blush. NJ 109 is probably too close to 'Ginger Gold' in fruit type, has a later harvest and as such is not competitive and not recommended for trial.

'Orin': A Japanese cultivar noted for its unusual texture and sweet flavor, 'Orin' received poor ratings in the NE183 due to susceptibility to russetting. Niche market only.

'Pacific Beauty': A new variety from New Zealand, Warner (2002) describes this cultivar as vigorous, prone to biennial bearing and sensitive to frost. The large fruit ripens about one week before 'Gala' and have a short storage life. 'Pacific Beauty' is only available through a licensing agreement.

'Pacific Rose': A 'Gala' x 'Splendour' hybrid developed in New Zealand that is being grown in Washington State under a franchise agreement with ENZA. While there are no tree royalties, growers must pay a franchise fee of \$2,000/acre and 11 percent of the f.o.b. price as a production royalty (Warner, 2002). 'Pacific Rose' is prone to vascular nodules, biennial bearing, and russet.

'Pink Lady' (Cripps Pink cv.): (USPP#7,880). Introduced in the early 1980s by a breeding program in Australia. A medium sized attractive pink apple with good flavor and texture. Very late maturing ripening, 1 to 2 weeks after 'Granny Smith', so it will not mature in New York and is not recommended.

'Runkel' ('Rip Van Runkel'). Chance seedling ripening in the early 'Fuji' season. Not recommended for planting in New York due to its poor fruit quality.

'Sansa': (USPP#6,519). A hybrid of 'Gala' x 'Akane', this cultivar has good fruit color and quality for the early season. Growers must insist on virus-free trees since 'Sansa' has a genetic mottle that weakens the tree if viruses are also present. Recommended as an early apple.

'Scifresh' ('Jazz'): The newest

offering from New Zealand is a hybrid of 'Gala' x 'Braeburn'. This cultivar is not available for testing in the US at present and will probably be a franchise cultivar.

'Silken' (BC 8S-4-33): (USPP#10,740). A 1999 release from Summerland, BC, 'Silken' is a hybrid of 'Honeygold' x 'Sunrise' that has a unique creamy pale yellow skin color. It ripens in the early 'McIntosh' season and is very aromatic. In preference tests, it is equal to 'Gala' and rated better than 'McIntosh' in flavor and texture (Quamme et al., 1998b). 'Silken' is said to have a storage life of about 10 weeks and is best suited for direct sales. PICO lists as one of the most promising early apples to test.

'Silken' was harvested 9/10/01 in Geneva. The fruits were very attractive to birds and had early damage. Fruits were mostly clean, but some stem cavity russet extended over the shoulders of the fruit and some body russet occurred. Fruits are slightly lobed, conic and have a slightly open calyx, long stems and a very small core. Sunburn was noted on some fruits before harvest, but was not extensive. A few fruits were cracked or doubled. 'Silken' is not for long storage. The unique appearance is a plus, but its harvest with 'McIntosh' is not

'Shizuka': A sister seedling of 'Mutsu' that received interest because it might be less susceptible/resistant to blister spot. Fruits are similar but sweeter in taste. Growers with 'Shizuka' are encouraged to report their findings relative to blister spot resistance.

'Suncrisp': (USPP#8,648). This cultivar's intense flavor is unique, but its susceptibility to mildew, blister spot and soft scald may restrict its commercialization.

'Sundowner': (USPP#8,477). Another late maturing hybrid of 'Golden Delicious' x 'Lady Williams' released by breeders in Australia. Matures too late to ripen in New York.

'Sunrise': An early-season apple from the Summerland program that has too short a storage and shelf-life to be recommended for trial.

'Zestar!™ (originally called 'Zesta', cv. Minnesota 1824): (USPP#11,367). Introduced by the University of Minnesota in 1998, 'Zestar' is a hybrid of 'State Fair' x Minn. 1691 that ripens with 'Paulared'. It may overlap in harvest with 'Gala'. It has a good sugar/acid balance and is juicy with white flesh. Its short shelf life may limit it to local marketing only. Reported to be hardy to -25°F. Trees are above average in vigor, but are said

to settle down. Trees are susceptible to scab. Some fire blight has been observed. Trees bloom very early, with 'Idared', so an early pollinizer is needed.

Blister spot of the fruit was noted in Geneva, where 'Zestar!' was harvested on 8/31/01. Fruits are oblate, slightly lopsided, with 50-70 percent blotchy red blush on a yellow/green background. Russet occurred in the stem cavity, over the shoulders and on some lenticels. Fruits have a short stem, a very large core and a slightly open calyx. The texture is not like 'Honeycrisp' as 'Zestar!' is very fine textured (slightly soft), very light in density and not as crisp. 'Zestar!' has good sugar levels and high acidity (0.62) and large fruit size. For trial by those who have a market for an early variety. Fruits had some bird damage and some pre-harvest drop from this damage. 'Zestar!' should be planted away from areas with heavy fire blight, black rot or blister spot inoculum.

Scab Resistant Cultivars and Selections

Some of the information in the description of Co-op and PRI selections was obtained from <http://www.purdue.edu/newcrops/apples/>.

'Sundancer' (Co-op 29): 'Golden Delicious' x 1050 NJ 1. Primarily a yellow/green apple with 20 to 60 percent mottled pink/orange blush. 'Sundancer' is reported to have resistance to scab, cedar apple rust and mildew. 'Sundancer' was harvested on 10/24/01 in Geneva. After storage it was still firm, dense, of good quality (spicy) and held up well, though fruits were slightly dry. The fruits get slightly greasy in storage, have an open calyx and a short stem. Fruits had extensive russet over the shoulders, body and lenticels, and there was some cracking in russeted areas. No storage disorders were noted, but 'Sundancer' is not recommended due to extensive russet development in our region.

Coop 39 (CLR20T14, PRI 2712-7). A complex hybrid that is scab immune, but moderately susceptible to mildew and to foliar cedar apple rust and is susceptible to fire blight. The very attractive red fruits are ovate and 2 1/2 to 3" in size. The texture is extremely crisp. Moldy core and calyx end rot has been observed. The fruits are not susceptible to pre-harvest drop and hang on the tree well. Co-op 39 ripens from September 7-21 in Indiana. The very rich flavor of the fruit may weaken in storage.

In Geneva, fruits were harvested on 10/3/01. Fruits may get greasy in storage. The fruits were oblate with russet on the calyx end and the body of the fruit. Some fruits had extensive russet. Fruits also had a very open calyx and a short stem. Flesh is cream colored and still firm after storage, but with a slightly moldy "off" flavor. Only for limited testing for those with a strong interest in scab resistant cultivars.

CQR 10-T17 (PRI 3217-3): A complex hybrid of a New Jersey selection x an Illinois selection. CQR10T17 is cedar apple rust susceptible. It is also very susceptible to watercore, which may disappear in storage. Fruit size is 2 1/2" to 3".

In Geneva the bright orange red, stripe/blush could be attractive, but fruits were irregular in shape, slightly lopsided and ribbed. The very short stems resulted in many stem pulls. Open calyx. Fruits had a russeted stem cavity, tough skin, open calyx and were very greasy out of storage, but were of good flavor and firmness. Only 40 percent of fruits were free of storage disorders, with senescent breakdown, watercore and moldy core prevalent. Not recommended for trial due to storage disorders.

CQR 12-T50 (PRI 3175-1): Selected at Purdue. NJ 75 x DIR101T117 (a New Jersey selection). Moderately heavy frog eye leaf spot infection on foliage. May develop off flavor (aldehyde) in storage. Ripens September 15 in Indiana, where it is russet free.

CQR 12-50 was harvested 9/19/01 in Geneva. The fruits are yellow and oblate with 10 to 30 percent pinkish orange blush. Fruits have a very short stem and a small open core. The stem end russet is very dark and unappealing and the body of the fruit sometimes has russet. No storage disorders were noted. Fruit were still juicy and slightly crisp following 32°F storage.

'Enterprise': (USPP#9,193). A scab resistant cultivar with fruit that resembles 'Rome Beauty'. Fruits are large, but the quality is poor. Skins are very thick and objectionable. Can have calcium related surface corking. Not recommended for trial.

'Galarina': A hybrid of 'Gala' x 'Florina' developed at INRA in Angers, France, and released cooperatively with breeders from Quebec, Canada. When tested at Geneva, this selection had one occurrence of stem russet that was so pronounced and raised as to be objectionable. Information is available at

http://www.pgris.com/partners/apple/galarina_descriptions.html/.

'Goldrush': (USPP#9,932). Excellent intense flavor (very acid) and storage life, but appearance is a limitation to commercialization. Does well in you-pick operations. Very susceptible to mildew.

'Pristine' (Co-op 32): (USPP#9,881). An early yellow apple that ripens with 'Lodi' and has high acidity. It can be strongly biennial and has a poor shelf life.

'Scarlet O'Hara' (Co-op 25). (USPP#12,323). A scab resistant release from the PRI (Purdue, Rutgers, Illinois) cooperative (Janick et al., 2000). Late ripening and of good quality, good firmness and stores well. 'Scarlet O'Hara' can be biennial. Several trees were lost to fire blight in 2001 at Geneva. Its susceptibility to fire blight and to moldy core are the two biggest concerns relative to commercialization.

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Susan Brown is a professor in the Department of Horticultural Sciences in Geneva who heads the apple breeding program. Kevin Maloney assists her as a Research Support Specialist working in the Apple Breeding Program.

2001 IDFTA European Tour: Integrated Fruit Production in Europe

Deborah I. Breth

Area Extension Educator, Lake Ontario Area Fruit Team, Albion, NY

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The IDFTA summer tours are great opportunities to see how apple industries are doing in other parts of the world, and to get to travel with and learn from fellow fruit growers from other parts of the U.S. and Canada. My goal of the 2001 IDFTA Tour was to learn first-hand about Integrated Fruit Production (IFP) in Europe.

We traveled to Angers, France, Switzerland, Bodensee region of Germany and South Tyrol, Italy. South Tyrol has approximately 40,000 acres of apples and pears planted in the valley, with hay and pasture on the higher elevations and slopes, and grapes on the hillsides. It is impressive to see such a concentrated, historic agricultural region (Fig. 1).

The concept of Integrated Fruit Production (IFP) began in Europe in the 1970s. The standards that were created

by the International Organization of Biological Control of Noxious Animals and Plants (IOBC) and International Society of Horticultural Science (ISHS) were updated again in 1999. These standards define IFP as “the economical production of high quality fruit, giving priority to ecologically safer methods, minimizing the undesirable side effects and use of agrochemicals, to enhance the safeguards to the environment and human health.” IFP is driven by social concerns for overproduction, endangerment of wild species, and pollution of ground and surface water identified with intensive farming.

The IOBC is a certification organization with a given set of guidelines and requirements for certification, but not all IFP standards set for each country or Cooperative conform to these standards. IFP is a set of “good

agriculture practices.” Within the IFP standard, Integrated Pest Management (IPM) elements are identified usually on a regional or national scope listing available pesticides for use under three categories — permitted (“green list”), permitted with restrictions (“yellow list”), not permitted (“red list”). These categories are based on toxicity to man, toxicity to key natural enemies,

Integrated Fruit Production in Europe is defined as “the economical production of high quality fruit, giving priority to ecologically safer methods, minimizing the undesirable side effects and use of agrochemicals, to enhance the safeguards to the environment and human health.”

This article highlights common IFP practices in Europe from the 2001 IDFTA European summer tour.

toxicity to other natural organisms, pollution of ground and surface water, ability to stimulate pests, selectivity, persistence, incomplete information, and necessity of use.

IFP is intended to be a holistic approach extending over the entire farm, sustaining agriculture and its relationship with society. Sustaining the multiple functions of agriculture in society is included in the many goals of IFP. Agriculture has to meet the needs of the entire society, including the production of food and fibre, diversified landscapes, wildlife conservation, and maintenance of local cultural traditions. These are some of the non-agricultural environmental and recreational values provided by operational farms. The guidelines are intended to cover every aspect of the production through harvest, storage, and packing of the produce. The goal is to have “traceability” of fruit from orchard block to the consumer.

IFP Standards

The IFP standards include requirements for:

- Variety/rootstock selection – usually dependent on regional recommendations but do not go as far as requiring disease resistance.



Figure 1. The picturesque South Tyrol where 40,000 acres of fruit are grown. Many of these acres are grown using IFP practices.

- Soil fertility – encourage inputs and proper tillage techniques to maintain soil structure
- Nutrient management – apply fertilizers based on a soil and foliar analysis done at least once every 3 years
- Biodiversity in flora and fauna – there are several ways to comply with this requirement but it encourages a mixture of animal and plant species that may serve as predators or sources of predators to manage pest pressure
- IPM with “Sacred Cows” – standards are more specific on a regional basis, but standards require the protection of two species within the orchard that can provide benefits in pest management.
- Irrigation – application of water should depend on evapo-transpiration rate for an area or information regarding specific water needs for a crop.
- Spray equipment care – spray equipment is to be calibrated annually and well maintained.
- Pre-harvest quality measurements – fruit quality measurements such as pressure and brix at harvest are to be recorded for each variety in each block harvested.
- Post-harvest management – must follow restrictions on any applications for post-harvest treatments, ensure traceability of fruit from specific orchard block to the customer.
- Animal production – relates to integrating animal production into the whole farm system, manure management, etc.
- Sanitation and hygiene – include requirements for personal hygiene protocols for workers on farm, and how to manage the produce at harvest to avoid contamination.

This is not a comprehensive list. Some examples of some of the standards follow.

The major disease and insect problems noted in all four countries visited include apple scab, powdery mildew, fire blight, wooly apple aphid, and codling moth. In France, a grower reported that borers (in burrknots) are becoming an increasing problem.

For apple scab control, growers use a program of contact fungicides when possible and DMI’s (similar to Rubigan or Nova in the USA) mixed with contact fungicides or they use strobilurines if they are registered. There are restrictions on the number of applications of mancozeb due to its impact on predator

mites. Mancozeb can only be applied four times per season but only two applications can be applied in succession to minimize the impact on the predator mite population. Standards for specific areas can include cultural practices to help reduce overwintering inoculum such as urea applications to the dropped leaves or chopping the leaves to increase the rate of decomposition. They are also developing markets for disease resistant varieties such as Topaz.

Fire blight was a concern everywhere we went, although we did not see any infections. In general, Europeans are concentrating on eradication programs for infected trees and susceptible alternate hosts in the wild and cultivated gardens. Most European countries do not allow streptomycin for agricultural use. And nothing works as well as streptomycin in controlling blossom blight. According to Kurt Werth, our guide for S. Tyrol, fire blight was found in the Bolsano area in a pear orchard. This orchard was eradicated and none has been seen since. Fire blight may be less of a problem in that area since they tend to have cool bloom periods, and their industry is based on the less susceptible Golden Delicious they are known for. Their apple industry is now switching to produce more Gala (25%), Braeburn (10%), and Pink Lady (10%)—all fire blight susceptible varieties.

Codling moth is the primary insect pest in Europe. It was first controlled in most areas with mating disruption and the elimination of broad-spectrum insecticides in the IFP programs. Subsequently, the Tortrix moth became a problem and damage by codling moth exceeded the threshold of 5-10% required for the use of mating disruption. Where mating disruption was used, the pheromone was hung in all fruit crops in the area. The next step for control was to include the use of insect growth regulators (IGR’s) such as phenoxycarb (Insegar) or tebufenozide (Mimic a.k.a. Confirm). These IGR’s also controlled Tortrix moth. They have also incorporated the use of Granulosis virus, which infects codling moth. Applied during a two week egg-laying period, each spray is effective for a week. When growers use mating disruption, the pheromones are applied to all apple orchards and surrounding fruit plantings that are not apples.

Wooly apple aphid appears to be a problem although Europeans do not do

anything to try to control it. They rely on biological control using a parasitic wasp that was imported with the aphid from North America to keep it in check.

Mites are managed by establishing a predator mite population of *Typhlodromus pyri*. Vineyards are the source of this predator mite; woody grapevines are pruned from vineyards where *T. pyri* are established. They cut pieces of the canes (Fig. 2) where predator mites overwinter and transfer them to the orchards to establish a predator population. Then a pre-bloom oil application is made to kill the overwintering red mite eggs. They let *T. pyri* do the rest. This is considered one of the “sacred cows” in the system. The pesticides toxic to *T. pyri* are restricted or not permitted under IFP standards. Mancozeb is restricted to two applications in succession (maximum of 4 per season) to minimize the impact on *T. pyri* populations.

Fruit thinning methods vary from one region to another. Carbaryl currently can only be applied early in the season for thinning, and in many countries, even this use will not be allowed in the near future. In France, thinning is done with NAA and carbaryl; but in S. Tyrol, Italy, it is not warm enough during thinning to use NAA, so more growers rely on NAD. Handthinning is the preferred method for thinning in IFP programs. Many European countries are reluctant to approve plant growth regulators, especially Germany.

Enhancing Biodiversity

Enhancing biodiversity is an important concept incorporated into IFP guidelines. Predator mite preservation contributes to the requirement for enhancing biodiversity. Another way to increase biodiversity is to encourage birds (especially hawks) to nest and perch in orchards (Fig. 3). These and other birds are intended to keep rodent populations in check, and feed on insects in the orchard. In Switzerland, old apple trees are cared for as “historical” trees to preserve the look of the countryside. Owners are paid 30 Swiss Francs per year per tree to care for the trees.

At FIBL, the Research Institute for Organic Farming in Frick, Switzerland, we saw another way to encourage wild bees to nest around orchard areas by building a mud wall or using old fire wood.”

We also learned about “ecological compensation land” to enhance



Figure 2. Grapevine cane pieces are cut and hung in orchards to transfer the predatory mite *Typhlodromus pyri*. This is the same predator as in Western New York.

biodiversity. In organic standards, 7% of the land must be designated as ecological compensation land, unmanaged, no herbicide, insecticide, fungicide, and left unmowed part of the year to encourage diversity in animal life. Examples include the ditches, or headlands of an orchard, or rock piles. IFP standards require about 3% of the land under this program and growers are subsidized for this practice.

Ground cover management was similar across the tour stops. All tree rows were fairly clean, with narrow herbicide strips under the trees. All seemed to have dead plant residue, not completely bare ground. They used systemic post-emergence herbicides such as Roundup or Basta (Rely), the one residual type herbicide more commonly used is diuron which must be tank mixed with a post-emergence herbicide. One grower we visited used a rotary hoe cultivator and followed up with tree bark mulch in his organic block (Fig. 4).

We saw two methods for bird control. Some orchards used bird netting with a complete enclosure, and the other sites used the recordings of bird distress calls or raptors.

Throughout Europe, especially in Germany and northern Italy, we saw very tidy operations. Equipment was well maintained, and clean and posed little hazard of pesticide exposure. Sprayer

calibration is required by IFP annually and records must be kept of all applications made in each block. One grower in S. Tyrol stored each implement on its own cart for easy storage and access.

The cold storage facilities we visited were built of insulated panels with a finish coat on both the inside and out. The whole room could be pressure washed for cleaning. Sanitation is an important IFP requirement in the storage and packing houses. In France, we were told that they are phasing out wooden bins and would only be using plastic bins in 10 years because they are more easily cleaned. Some of these costs could be subsidized by the European Union Quality Program.

IFP requires professionally trained, and environmental and safety conscious growers. In Germany and France, there is no government supported Extension Service. Former Extension personnel have become employees of either the IFP certifying organization or the grower coop. They run prediction models for diseases and insects for sites in their region. They teach growers how to scout for pests. They disseminate the information by fax, phone and newsletters. Growers are required to attend at least one twilight meeting every month. In Germany, there is still federally supported research, but, in France, much of the research is supported by grower coops.

IFP certifying organizations, often packinghouse coops, frequently use a "points for practices" system to evaluate individual farms for certification. It is not necessary to use all elements in the IFP guidelines to achieve certification. Points are deducted from the maximum total possible for each case where the recommended practice is not followed. A minimum score must be attained for a grower to be certified. There are different types of point systems used depending on the organization. Some IFP programs or certifiers do not use a point system.

Tracking Accountability

There are several controls built into the system to ensure

that growers adhere to the standards. The first accountability tool is the record-keeping done by the grower to record all activities on the farm. It is not enough to follow the standards, it all has to be written down. Records must include soil and foliar analysis results, fertilizer applications calibration records, spray records, and scouting record that justify any spray applications. Some "restricted" insecticide applications require a written prescription by a consultant. These records are important to document any activities that cannot be measured during an inspection. The records are submitted annually to the certifying organization. A surprise visit is arranged for another grower from the Coop to visit and oversee activities on the farm. During the season, the Cooperative can collect leaf and fruit samples for residue analysis to confirm that pesticide restrictions are being followed. And, finally, the government can send a representative to collect leaf and fruit samples for residue analysis and sample spray tank mixtures. So there are many steps taken to ensure IP standards are followed.



Figure 3. Birdhouses are installed in orchards to encourage bird predation of rodents and insects.



Figure 4. Mulch to control weeds is increasingly being used as part of an IFP program.

In addition to all the perceived environmental benefits, what are the other benefits of IFP? The benefits are not measured in dollars returned to the growers, but IFP does provide access to markets. And the elements of IFP can be a source of pay checks from the government. The EU Quality Program will pay 50% of the cost of an activity that will improve quality or address market needs up to a maximum of 4% of the gross of that product on the farm. France

invests their quality program funds into hail netting and plastic bins. Other countries use those funds for pest management programs on the farm, and to help pay the consultant fees. Finally, many other federal, state and local subsidies are paid for because of perceived environmental improvements in agriculture.

This quick overview of some of the highlights of the 2001 IDFTA European tour is not a detailed scientific study of

IFP in Europe. It is another opportunity for us to better understand how the Europeans are accomplishing their goals in IFP. This information should help us understand what might be required to continue to market our fruit in Europe.

Debbie Breth is Pest Management Educator and Team Leader for the Lake Ontario Fruit Program. She specializes in IPM issues.





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